Materials & Methods

Selection & use of
metals, nonmetallics, parts, finishes,
in product design & manufacture

Design Engineering Show Preview SEE PAGE 19

M&M Awards Competition Winners
for the Best Use of Materials in Product Design SEE PAGE 147

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- Columbium and its Uses
- Aircraft Materials—Present and Future
- Polyamide Protective Coatings
- Selecting Silicone Rubbers

May, 1957

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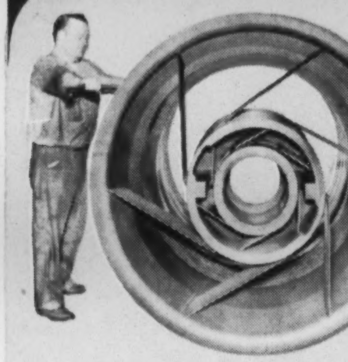

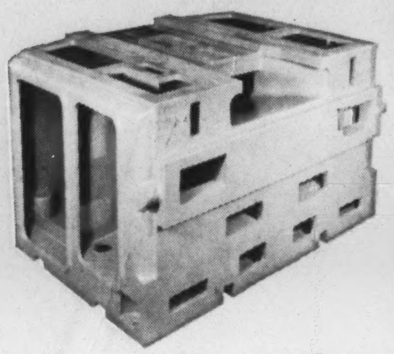

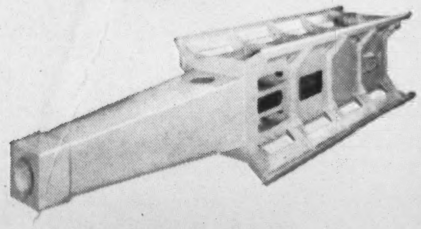

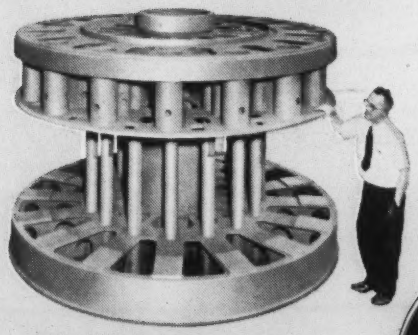

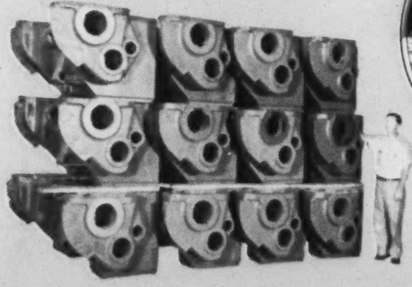

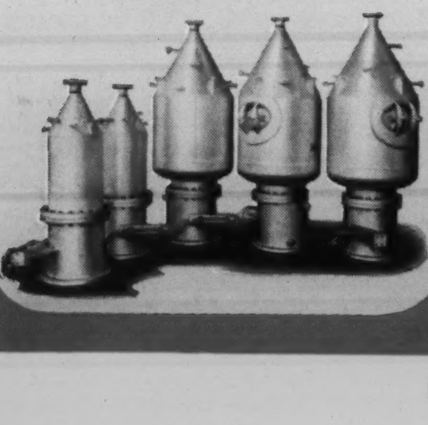

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The 35-Ton Weldment above is the Center Section of a three-section Bed for a large Underdrive Press. This piece, and the units illustrated at the left, are typical of thousands of Steel-Weld Fabricated parts and assemblies produced by Mahon for manufacturers of processing machinery, machine tools, and other types of heavy mechanical equipment. It is possible that you, too, could benefit by the economies and other advantages offered by welded steel components in your product. In any type of heavy machinery there are parts and sub-assemblies that can be produced more economically and more satisfactorily in welded steel, because, in weldments you get greater strength with less weight, plus the additional advantages of greater rigidity and predictability. Before you place an order for weldments, you will want to discuss your requirements with Mahon . . . because here is a unique source for welded steel in any form . . . a reliable and responsible source with complete facilities for design engineering, fabricating, machining and assembling . . . a source where advanced fabricating techniques are supplemented by craftsmanship which assures you a finer appearing product embodying every advantage of Steel-Weld Fabrication. See Sweet's Product Design File for information, or, better still, have a Mahon sales engineer call at your convenience.

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Materials & Methods®

Selection & use of metals, nonmetallics, parts, finishes in product design & manufacture

MAY 1957 **VOL. 45, NO. 5**

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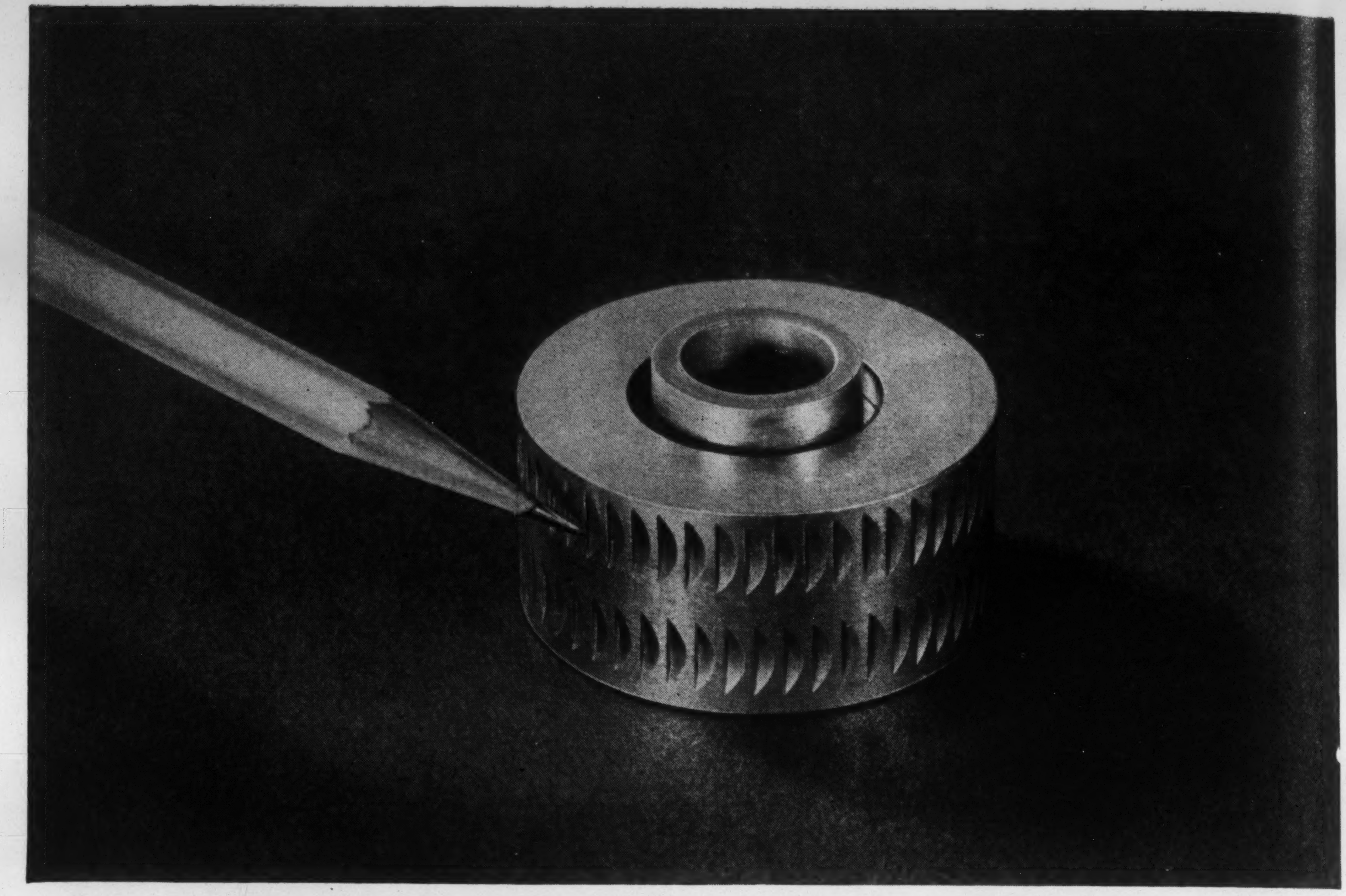

Here is a close-up of a 2-inch-wide ring roller made of cast "H" Monel alloy. Eighty of these rollers feed the hide-splitting machines used at Seton Leather Company, Newark, N. J. They are cast at the Inco foundry . . . where castings of any practical design or shape are turned out clean as a whistle. Free from distortion. Close as to tolerance.

Inco-cast ring rollers of "H" Monel help split the cost of splitting leather

Workers at Seton Leather Company, feeding freshly tanned hide to the cutting blade between two rows of rollers. The bottom ring rollers are made of cast "H" Monel for long life.

Hides are split to proper thicknesses while still wet from liming baths. And this can cause trouble in the hide-splitting machines.

When made of brass, the ring rollers that guide the skins wear out fast. *Often in 18 months or less.* They just can't take the hard wear . . . the corrosive tanning chemicals.

What's more, downtime and replacement costs are only a part of the expense. Worst of all is the damage done to the skins by defective brass rollers . . . damage that doesn't show up till later processing.

Faced with this problem, Seton Leather Goods Company — a manufacturer of patent leather — came to Inco. Inco Development and Research men recommended "H"* Monel hard corrosion-resisting nickel-copper cast alloy. Seton tried it: *got rollers that last four to six years.*

When you have a problem involving castings of corrosion-resisting alloys, get in touch with Inco. Perhaps "H" Monel or one of the seven other specially developed Inco-casting alloys is the answer for you, too. Each provides a combination of properties to meet special service conditions.

For complete information, write for Inco's new booklet, "Cast to Outlast."

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Inco Castings *. . . Sand, Centrifugal, Precision*

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What's new IN MATERIAL

...AT A GLANCE

WIRE-REINFORCED CERAMICS may soon help solve the brittleness problem long associated with this material. Interest seems to be growing for those applications where ceramics must be used for structural applications or where a certain degree of shock loading must be overcome.

NEW APPLICATIONS FOR CERAMICS include the use of this material in tools that are said to offer a longer tool life than conventional tools; in radomes that are resistant to heat, rain erosion and other service conditions; and in atomic fuel elements that are said to be radiation resistant and may soon be cheaper to use than metallic elements.

JOINING STAINLESS STEEL PIPE WITHOUT USE OF FILLER METALS is now possible with a modified inert-gas tungsten-arc welding technique. Advantages claimed for the technique are clean, strong and uniform joints in steel and stainless steel pipes. The technique involves special machining of the root edges. It was developed especially for joining pipe used in nuclear reactors where highly corrosive radioactive solutions must be contained.

A NEW THERMOPLASTIC RESIN, a polycarbonate, is said to have a greater degree of toughness, impact strength, heat resistance and dimensional stability than any previously developed thermoplastic. Tests conducted on the material show it to have a notched impact strength of 12 to 16 ft-lb per in., a heat distortion temperature of 280 to 290 F and a melting point of 514 F. Not yet available, the new polymer is expected to compete in certain areas with cast metals, ceramics and other plastics. (More details next month).

OUTDOOR WEATHERING TESTS ON PORCELAIN ENAMELED STEEL show large variations in weather resistance among 864 panels tested for 15 years at exposure sites in various parts of the country. Enamels affected least were those having good resistance to acid attack. The most resistant enamels retained over 90% of their initial gloss and showed insignificant color changes for the 15 year period.

HIGH PURITY VANADIUM METAL, said to be 99.5% pure, is on the market. Said to have good radiation resistance, the metal is recommended for use in seamless tubing used in nuclear reactors; as precision resistors; as cathodes for x-ray tubes; and as a melting stock in the production of certain magnetic alloys. It is available in the form of lumps, chips, cast or machined ingots and as hot-rolled plates and bars.

A BLACK POLYETHYLENE RESIN is now in commercial production. The medium density material, having a life expectancy of from two to four years, is designed especially for outdoor use. It is recommended for irrigation pipes and as a protective sheeting for farm equipment and harvested crops. (More details next month).

A NEW FLUOROCARBON RESIN is being produced by a new company in the field. Now in pilot plant production, it will mean more competition for existing trifluorochloroethylene materials (Kel-F, Fluorothene and Polyfluoron). The new trifluorochloroethylene resin (Genitron-HL) is said to have a highly consistent molecular weight, providing good consistency of properties.

AN INEXPENSIVE CLEANING PROCESS FOR COPPER improves its bonding properties and protects it against tarnishing. The process, suitable for batch or continuous operation, uses a 25% solution of ammonium persulfate in the form of a brief dip treatment. One gallon of solution is claimed to treat approximately 100 sq ft of copper surface at a chemical cost of a few tenths of a cent per sq ft.

A NEW VARNISHED POLYESTER TAPE, rated as a Class A insulation material, is now commercially available. An outstanding feature claimed for the tape is its good conformability, which seems to be better than any coated insulation presently available. According to the supplier, the good conforming characteristics of the tape may permit some electrical parts manufacturers to increase the dielectric strength of their insulation by approximately one-third without increasing the over-all dimensions of the completed electrical unit. (More details next month).

AN IMPROVED STEEL NITRIDING PROCESS, developed in Switzerland, is claimed to give steel parts a greater surface hardness than hitherto possible. The process uses a high current electrical discharge within an atmosphere of hydrogen and nitrogen gas to convert electrical energy into thermal energy. Advantages claimed for the process are low gas consumption, automatic control and large volume production. (More details next month).

INTEREST IN CERMETS for aircraft "hot spots" is fading in favor of alloy modification and in the development of alloys of some of the newer metals. The brittleness of cermets, though improved, still seems to be a definite limiting factor for such applications as turbine buckets.

Turn to page 181 for more "What's New in Materials."

MATERIALS BRIEFS

Foam Foils Frost
More than a million square yards of urethane foam will be used this year as interlining in overcoats and other outerwear garments. The lightweight foam is as warm as any interlining material now on the market and is easier to dry clean.

Long Distance Paint
A highly visible, orange-red paint will be used on aircraft to reduce mid-air accidents. Containing new pigments and ultraviolet light absorbers, the new paint can be spotted from long distances.

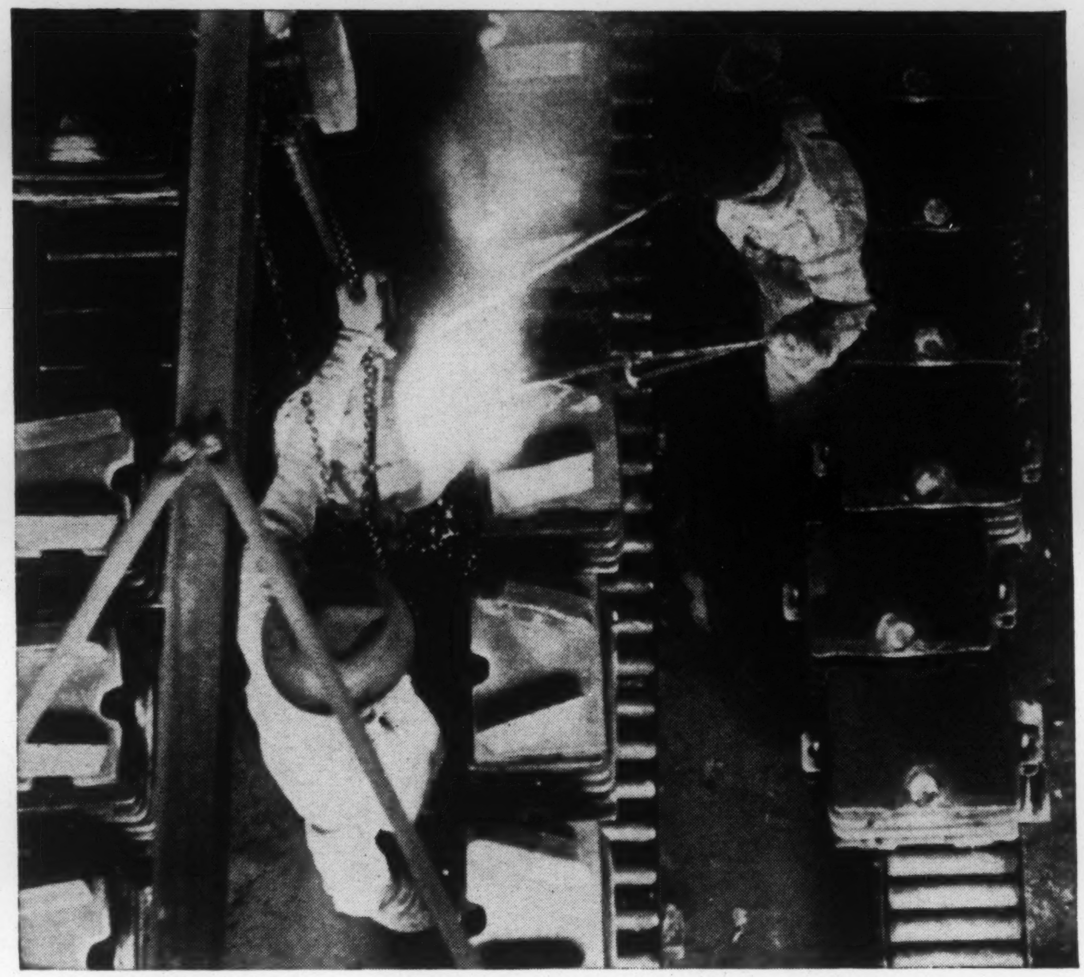
Buried Treasure
When plaster fell off a statue that was being moved, it turned out to be a 13th century, 5½-ton statue of Buddha. Valued at several million dollars, the statue is made of gold and a tin-zinc alloy.

Atomic Tire
Atomic energy has been used successfully to vulcanize a tire that is expected to wear longer than conventionally vulcanized tires. This represents the first basic change in curing rubber since 1839.

Hole in One
Better golf scores are possible with a new golf ball that is so sensitive to touch that a slight tap will send it flying. Designed for easy swinging golfers, the ball has a liquid silicone rubber center and an extra hard core.

Nonskid Sheepskin
A newly patented rug underlay consisting of a layer of sponge rubber and a corrugated rubber backing helps sheepskin and other fur rugs stay in one place.

Have you had trouble with Engineered Bronzes?



The truly engineered bronzes . . . silicon, aluminum and manganese bronzes . . . give desirable combinations of properties not available in any other metals.

If you need the physical characteristics of the engineered bronzes, but if you have had difficulty in achieving them in castings, it will be worth your while to try again with Federated products.

It is difficult to make these bronzes and only many years of experience and rigid quality control will produce the metallurgical qualities desired. At Federated, ingredient specifications are adhered to rigidly. Continual spectrographic and chemical controls are used during the alloying process. Experienced metallurgists are in charge. Performance specifications are always met or exceeded.

Let us tell you more about these valuable alloys. A Federated field man will be around to see you soon. Talk to him. It will benefit you.

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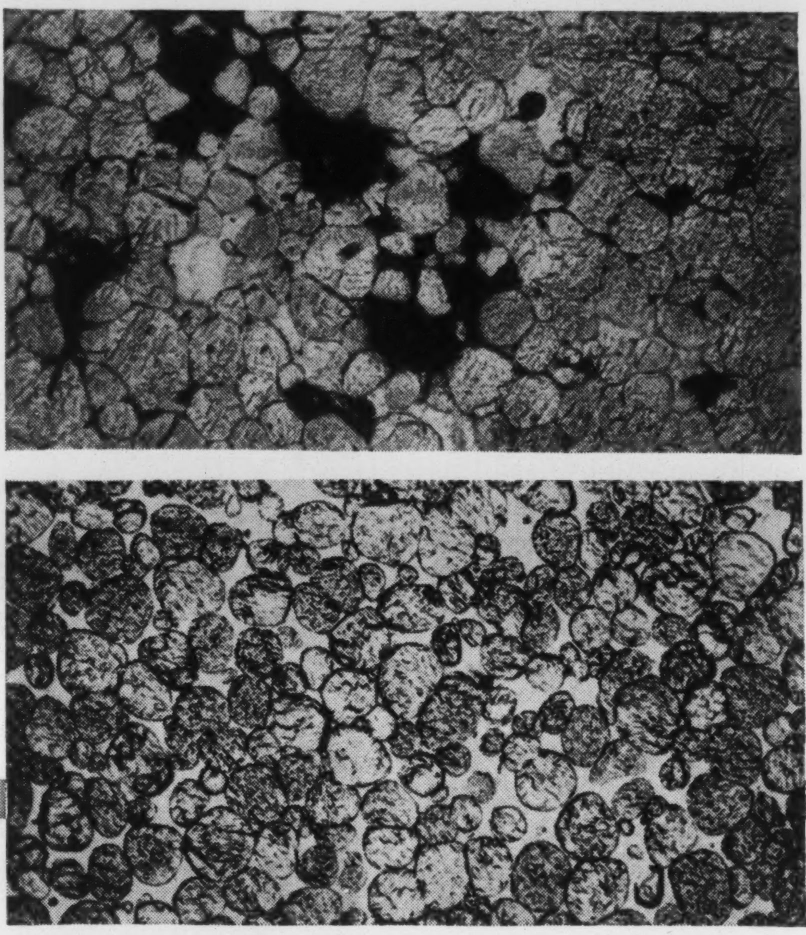

Under the microscope, ordinary shielding metals (above) reveal voids that seriously reduce radiation absorption . . . while Mallory 1000 Metal (below) shows high density, positive shielding all the way through.

Get predictable radiation shielding... with uniform Mallory 1000

THE HIGH DENSITY and superior radiation-absorbing capability of Mallory 1000 Metal extend through *every* part of *every* piece. Special Mallory manufacturing methods give this unique material an internal structure comparable in uniformity with forged metals.

To the designer of radiation shields, this superior uniformity permits calculations based on precisely controlled absorption characteristics rather than "average" or "typical" values. Safety factor allowances can be minimized to permit smaller parts and lower overall costs.

Mallory 1000 Metal is up to 40% more efficient than lead. It is being used at energy levels to 100 MEV, for source capsules, "switching" devices and similar purposes. Mallory contour pressing permits manufacture of intricate shapes to precise dimensions at economical cost. Mallory 1000 has high tensile and flexural strength, and machines readily to excellent surface finish.

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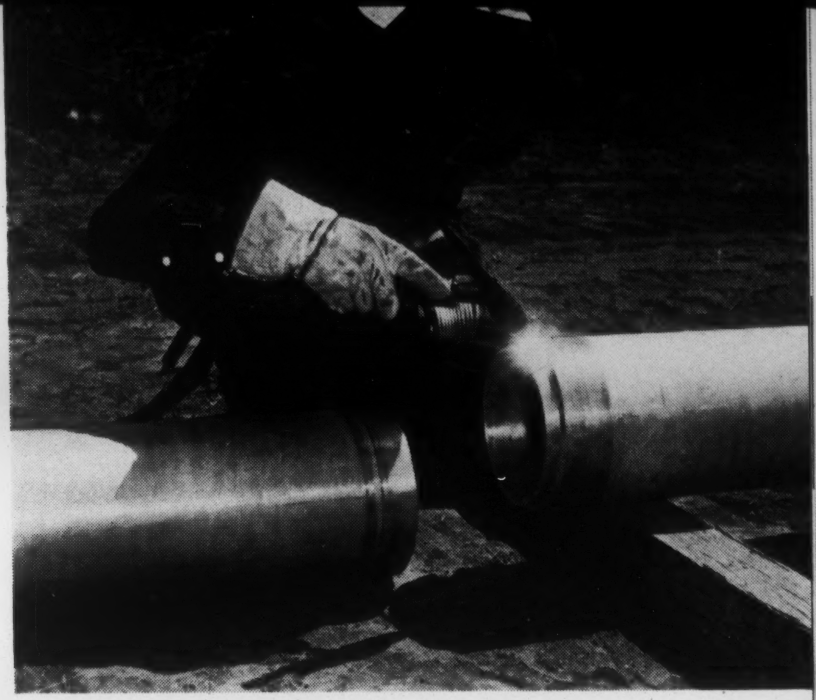
MATERIALS AT WORK

*New
and interesting
applications
of engineering
materials*



Pipeline welded *in 40-ft sections is . . .*

. . . installed *without protection in corrosive soil.*

Longest unprotected pipeline is made of aluminum

The use of aluminum for corrosion resistant pipelines has been given added impetus with the successful installation of what is claimed to be the largest, longest unprotected line now in service.

Installed by Lavaca Pipe Line Co. for Aluminum Co. of America, the gas-carrying pipeline is 8 in. in dia and 20,000 ft long. It is buried in soil ranging from sand and gumbo to salty marsh, yet has absolutely no protective covering. It is shielded only by electrical insulation at certain flanged joints.

Argon-shielded tungsten arc and consumable electrode welding methods are used to join 40-ft sections of the pipe. Gas flows through the line at 500 psi.

Light's in, rain's out with reinforced vinyl

The hatch tent shown here, made of translucent vinyl reinforced with Celanese's cellulose acetate fiber, permits normal loading and unloading of cargo in any type of weather; it keeps out the rain, but admits light.

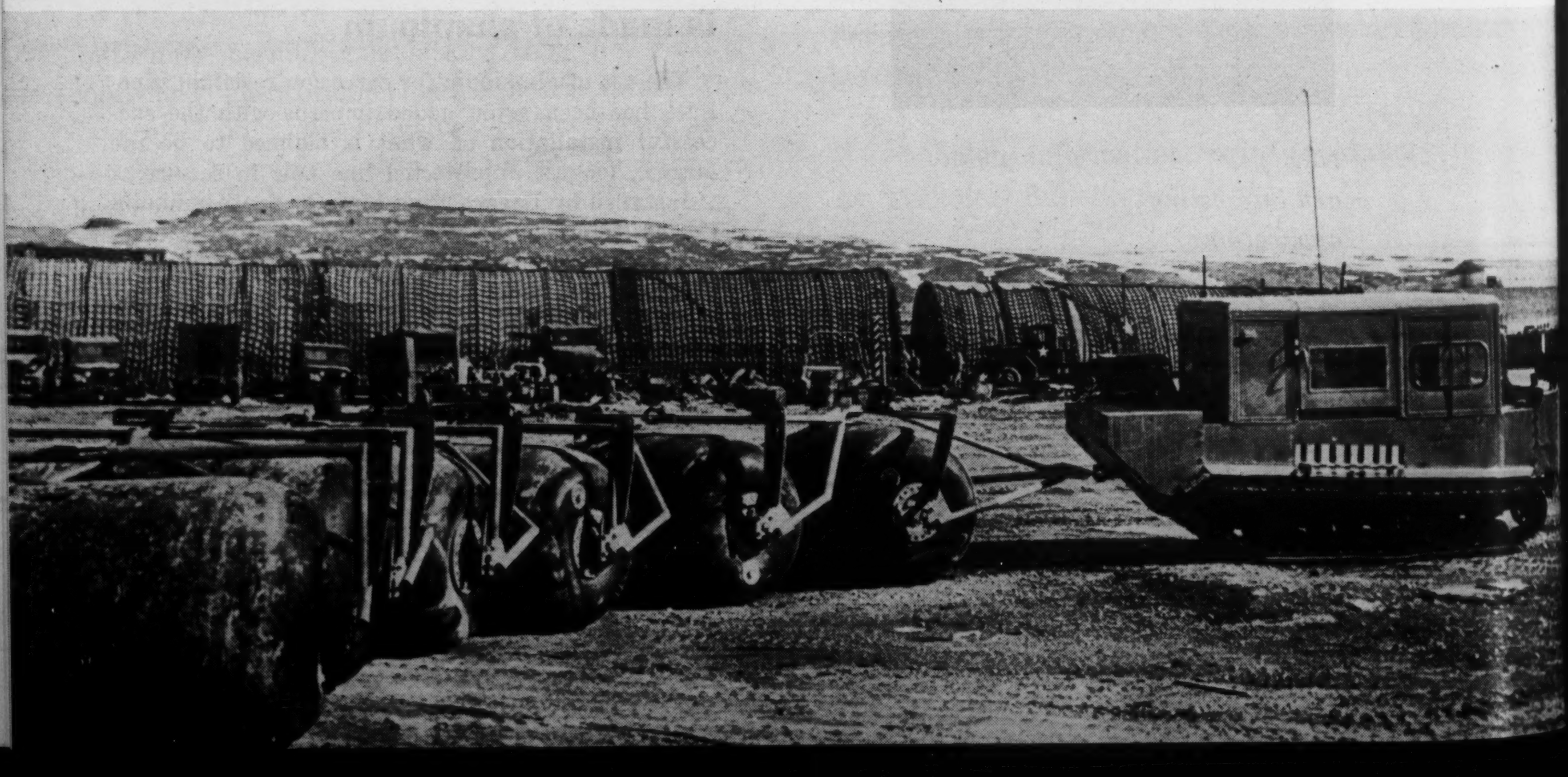
Manufactured by Herculite Protective Fabrics, the tent is 32 ft high and has a base measuring 29 by 45 ft. It is claimed to weigh only half as much as similar tents made of conventional materials, and it is resistant to mildew and rotting.

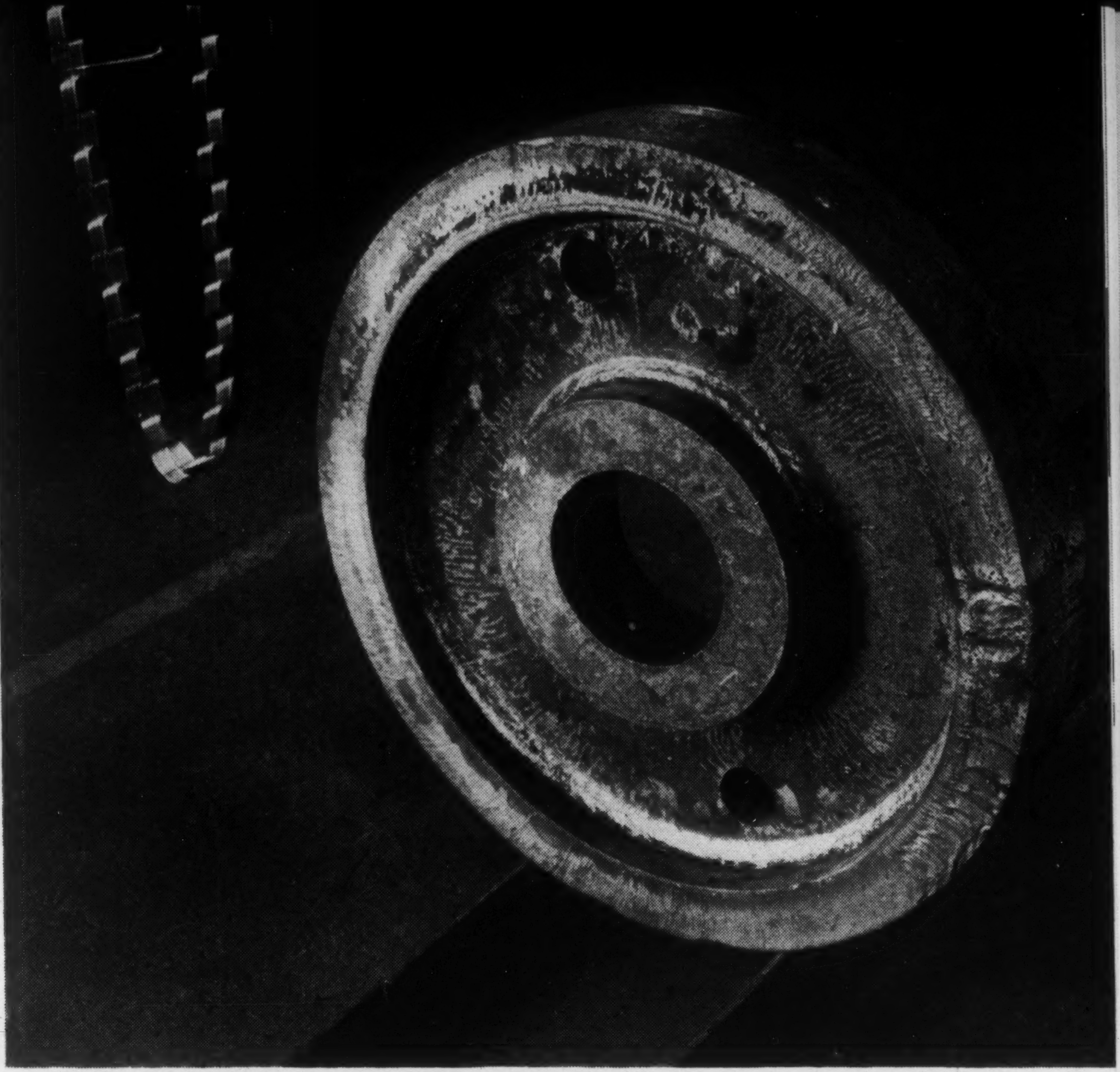
Rubber cylinders transport liquids

These oversized rubber balloons are used to transport bulk liquids such as oil, water or gasoline. The collapsible cylinders are actually inflated with the liquid to be transported.

Each of the rubber cylinders, produced by United States Rubber Co., has a capacity of 500 gal and is centered on an axle which is connected to a towing yoke. As shown here, several cylinders can be towed together in tandem fashion.

The fabric-reinforced rubber cylinders are capable of withstanding the effects of fuels and oils and can be safely stored in the field. So far they have been successfully used over ordinary and snow-covered ground, and they are expected to perform efficiently in desert areas and on marshy terrain.



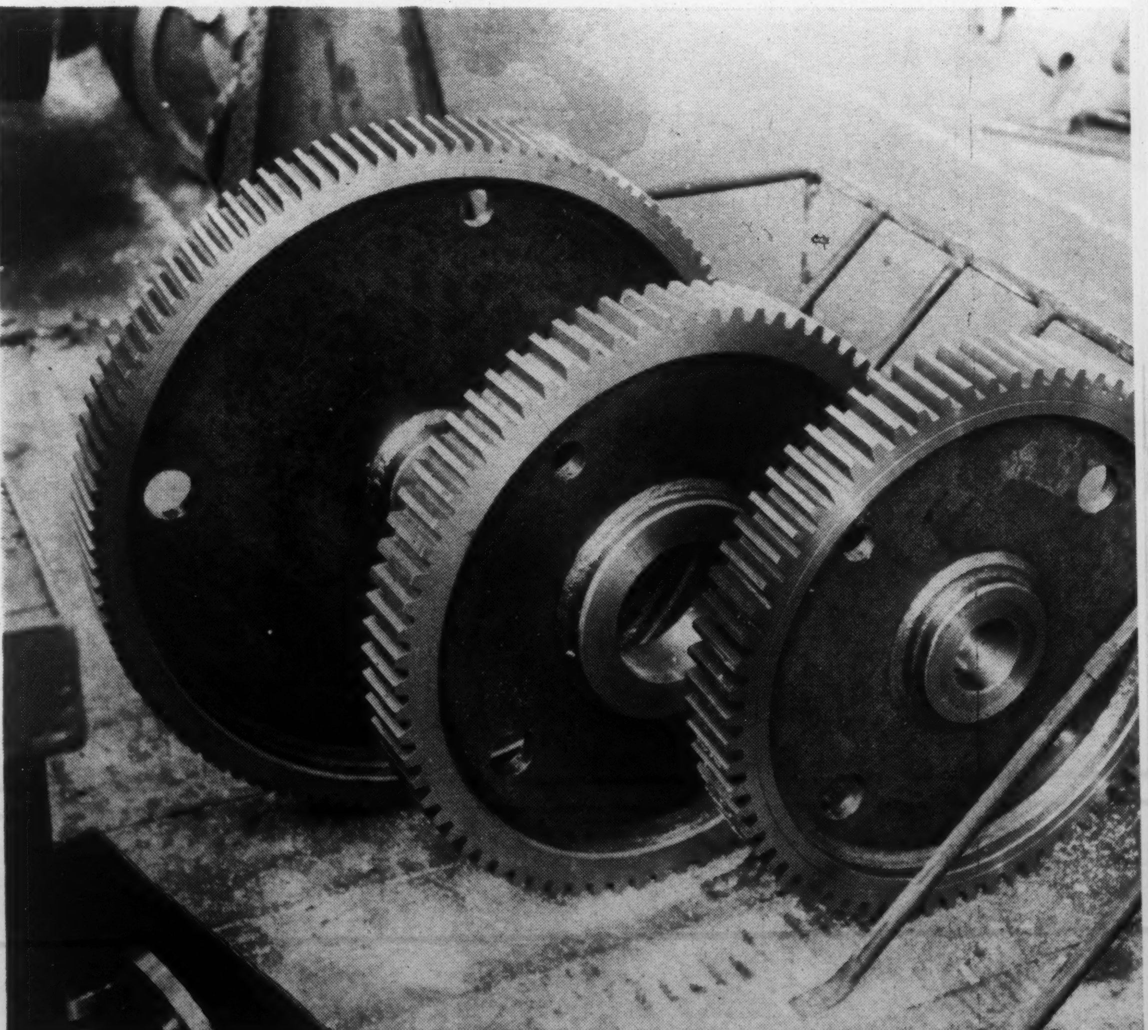


Large gears: cheaper and lighter when welded

By using automatic submerged arc welding, Lincoln Electric Co. is now fabricating steel gears varying in size from 14 to 60 in. in dia and weighing from 125 to 4300 lb. In addition to providing a weight saving of approximately 50% over cast steel gears, the fabricated gears eliminate the expense of patterns and are cheaper and easier to machine.

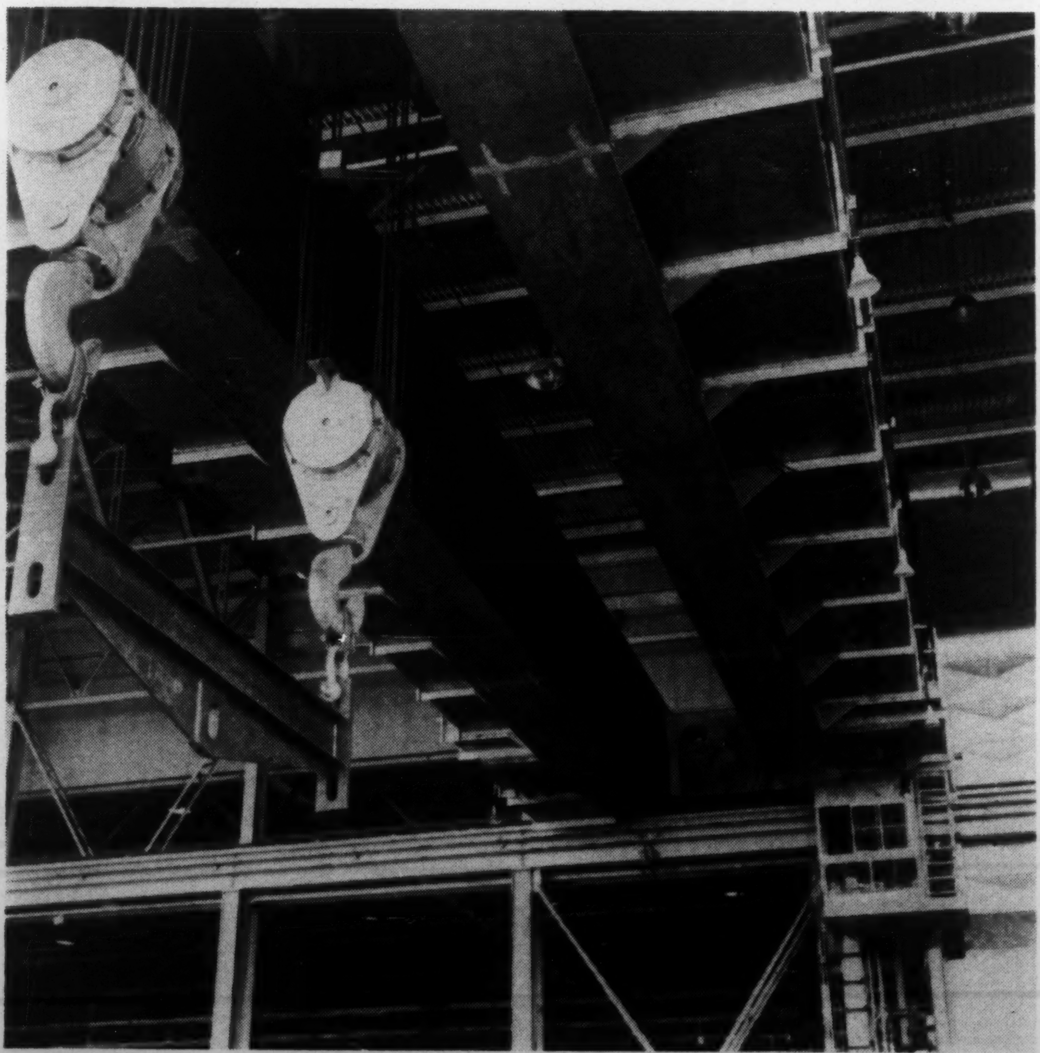
In fabricating a typical drive gear with a 25½-in. o.d., 8-in. hub dia and a 4½-in. tooth face, a rim is first formed of hot rolled steel to the approximate finished diameter. After cooling, a circular spider plate blanked to shape is pressed into the rim. A forged hub is then positioned in the spider and the entire unit is tack welded.

After tack welding, *two passes are made around the joint between the rim and the spider, providing a ⅜-in. fillet. The joint between spider and hub is welded in one pass. The blank is turned over and similar welds are made on the reverse side; then the gap in the rim is manually welded (above). When the welds are completed, the gear is normalized and pickled to remove scale. Finally the blank is machined to size and the teeth are cut (below). Note uniformity of beads at the joints.*



All-aluminum, *100-ton capacity, 105-ft span crane.*

Aluminum cranes need less support than steel



Bottom view *of 100-ton capacity aluminum crane.*

The country's first all-aluminum, welded mill-type cranes are now in operation. Designed, developed and fabricated by Cleveland Crane & Engineering Co. using Kaiser Aluminum's new high strength, weldable alloy 5083, the cranes range in capacity from 5 to 125 tons and span from 60 ft, 6 in. to 105 ft.

Although the aluminum cranes cost 3 to 8% more than steel cranes built to the same specifications, they are said to compare favorably with steel cranes for these reasons:

1. Initial installation costs on craneways, columns, footings and excavations can be cut by as much as 4% of crane cost as a result of reduced wheel loads necessary.
2. Where plant expansion requires higher capacity steel cranes, modification of craneway and its supports is necessary to withstand higher wheel loads. Aluminum crane capacity can be increased 25 to 35% without increasing wheel loads.
3. Savings in shipping costs amount to 1½ to 2% of crane cost.
4. Erection costs are about half.
5. Greater work-per-hour capacity.
6. Maintenance and painting requirements are negligible.

"New Underwater Workhorse
For Skin Divers"

Constructed With Sturdy, Dependable

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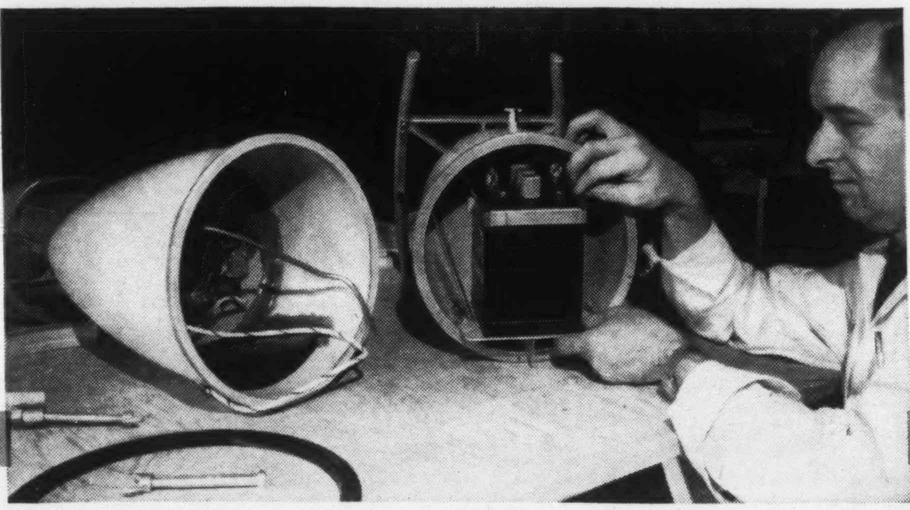

● Top performance under tough conditions . . . that's what's required of these one man underwater propulsion units made by the Link Aeronautical Corporation of Endicott, New York.

The basic shell material for this "Power Diver" must be able to withstand the pressures of 100-foot dives . . . must be able to resist the corrosive effect of the sea . . . and must still be light enough for a man to carry the unit out of the water. These are just some of the physical requirements that must be met for such a product as this . . . and met at a price that doesn't take the product out of the sportsman's reach!

"That's why we chose a combination of RCI POLYLITE and fibrous glass," states Felix Aimonetti, vice president and general manager of Link. "From the standpoint of design, engineering and cost, reinforced POLYLITE was the perfect solution for our shell material.

"Besides all this, the capital outlay we needed for this type of construction was relatively low, and we found that even without the benefit of prior manufacturing know-how during the first weeks of production, we were able to turn out a consistently uniform product. All things considered, the use of RCI POLYLITE reinforced with fibrous glass has cut our production costs at least 75%."

Products possessing the unique advantages of RCI POLYLITE — lightweight strength, durability, and easy maintenance — are becoming increasingly popular and profitable in today's market. Perhaps POLYLITE polyester resin can be incorporated into one of your products. For additional information about what you can do with RCI POLYLITE in laminating, molding or other plastics applications, write for free *Booklet A.*

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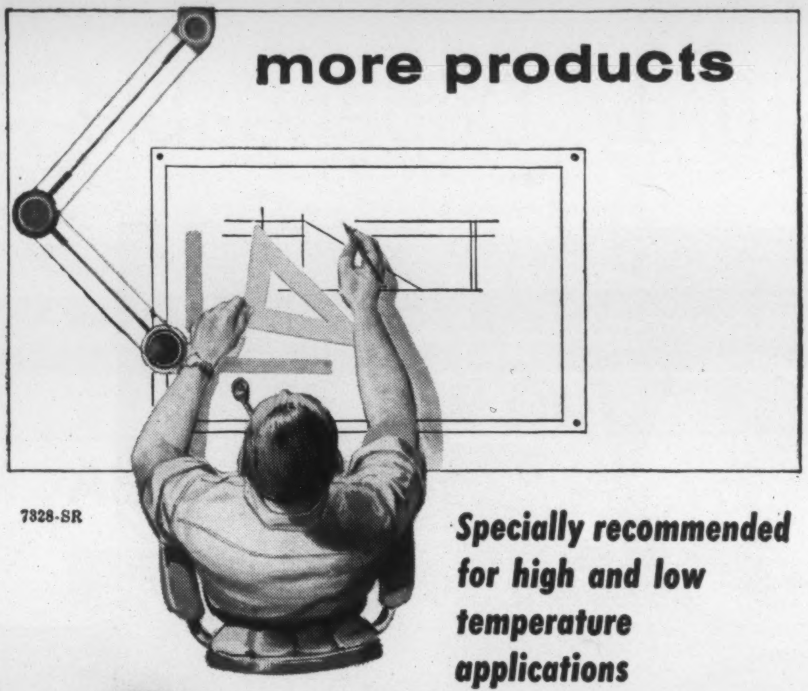

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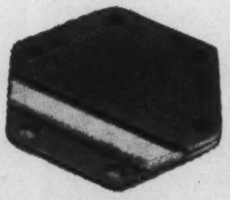

Silicone rubber parts by Stalwart are solving problems every day . . . and costs are being cut too!

Time and again, Stalwart Engineers have and will replace costly metal constructions forced on design engineers because of the limited thermal stability of organic rubbers.

Stalwart is prepared to produce precision parts from a variety of Silicone rubber stocks to meet your individual specifications. These parts will retain rubber-like properties at temperatures from −130° to +600° F. They will have excellent dielectric properties and resist compression set.

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For more information, turn to Reader Service Card, Circle No. 484

Letters to the Editor

Materials selection problem

To the Editor:

We have designed and built two tube mills for making large diameter, thin wall aluminum pipe (12-in. OD by 0.062 wall). This pipe is used almost exclusively for agricultural irrigation purposes.

Although these tube mills are working quite well and we have made many miles of pipe, we have a recurring problem of guiding and holding down the aluminum tube edges just prior to and just following the weld. We have found that Micarta is an excellent substance, as it is hard enough to last and yet will not gall the aluminum. Our problem is to find a material which will not gall and yet will stand sufficient heat to be placed within an inch or so of the actual arc. We have tried many materials for this and so far the one which we have found to be the best and are now using is graphite. This, however, lacks something in mechanical strength and replacements must be made fairly often.

ROGER M. SHERMAN
Chief Engineer
W. R. Ames Co.
San Francisco 7, Calif.

Two materials that might be investigated are: Refrax, made by Carborundum Co., Refractories Div.; and Borolite compositions, made by Schwarzkopf Development Corp.

Aides and bed pans

To the Editor:

I refer to your reply to a letter on "Engineers' Aides," published in your Nov '56 issue, in which you state that you believe the idea has been tried with mixed results.

"Mixed results" is right! A large corporation last year tried this on young men who didn't have the background to be called "Engineer"—even by the devious manpower-holding tricks used today.

However, we lost these men because they, and those who chivvied them daily, couldn't get out of their minds the title-implanted imagery of someone frantically running around with a bed pan!

RICHARD TISCH
Vice President, Product Development
A-P-D
Minnesota Rubber & Gasket Co.
Minneapolis, Minn.

Don't forget sheet metal

To the Editor:

I received your letter inquiring about the renewal of my subscription to MATERIALS & METHODS, and I was very pleased to discover your concern. I have renewed my subscription for the next two years and received my January copy. I have obtained a great

a new material

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a ***new*** *process—with*

a ***new*** *combination of properties*

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Letters
to the editor

many interesting and useful pieces of information from your publication that have been very helpful to me in my work. I do, however, wish at times that there was a little more information on common everyday sheet metal fabrication, and not quite so much on the application of plastics. Our product is mainly farm equipment and I just can't pour a potato harvester into a mold as cheap as I can hammer one out of steel and weld it.

You might also be interested to learn that Materials & Methods is a permanent part of our library and is the cause of many discussions . . .

Please continue to consider us among your subscribers, readers, and, sometimes, critics.

W. C. Van Horn
Chief Manufacturing Engineer
Food Machinery & Chemical Corp.
John Bean Div.
San Jose 1, Calif.

We will keep this suggestion in mind. The materials field is so broad, and developments come so thick and fast, it is sometimes difficult to reserve space for older and more prosaic materials.

Our prices please

To the Editor:

I would like to congratulate Materials & Methods on its new editorial format. I am particularly pleased with the new section giving prices of engineering materials. I don't believe any other publication presents as varied a coverage, and I am glad to have had a hand in the preparation of the price chart for organic finishes, which first appeared in the March issue.

Howard R. Rothenberg
J. Landau Co.
Carlstadt, N. J.

Care in handling beryllium

To the Editor:

You are to be commended for the manner of presentation of my article "Could Beryllium Be a Structural Material?" in the February '57 issue of M&M. The general layout was quite well done, but I would like to point out a rather serious error:

It was stated on p 103 that "beryllium can be handled with the same precautions used for lead." . . . Lead is a digestive poison; beryllium is a pulmonary and skin hyper-irritant. Many lives would be lost if the same precautions used for lead were used for beryllium. Fortunately most people investigating beryllium today are well informed as to the differences in the nature of the toxicity of lead and beryllium.

George A. Hoffman
Aeronautics Department
RAND Corp.
Santa Monica, Calif.

New York Coliseum

2nd Annual Design Engineering Show

and Design Engineering Conference

May 20-23, 1957

The Show

The Design Engineering Show, which has skyrocketed to a position among the top five industrial expositions in only one year, will be two and a half times larger than the initial show held in Philadelphia last year. Devoted exclusively to the design engineer's needs, the show will be composed primarily of exhibits demonstrating latest developments in engineering materials, and product design.

Technical experts from nearly 400 leading companies will be on hand to answer questions and give advice on the broad range of exhibits, which include metallic and nonmetallic materials; finishes and coatings; shapes and forms; fasteners; mechanical, electrical, electronic, hydraulic, and pneumatic components; and accessories for product development.

Visitors will be especially welcome at the MATERIALS & METHODS booths (425, 431), where the winning entries in M&M's First Annual Awards Competition for the best use of materials in product design will be on display.

The Conference

The Design Engineering Conference, running concurrently with the Design Show, will consider such problems as procedures in developing new designs and the electrical, mechanical and materials aspects of design engineering. (See complete program on the following pages.)

Sponsored by the Machine Design Div. of the American Society of Mechanical Engineers, the conference sessions will again have as chairmen the editors of the four leading design publications: G. F. Nordenholt, *Product Engineering;* F. J. Oliver, *Electrical Manufacturing;* Colin Carmichael, *Machine Design;* and H. R. Clauser, MATERIALS & METHODS.

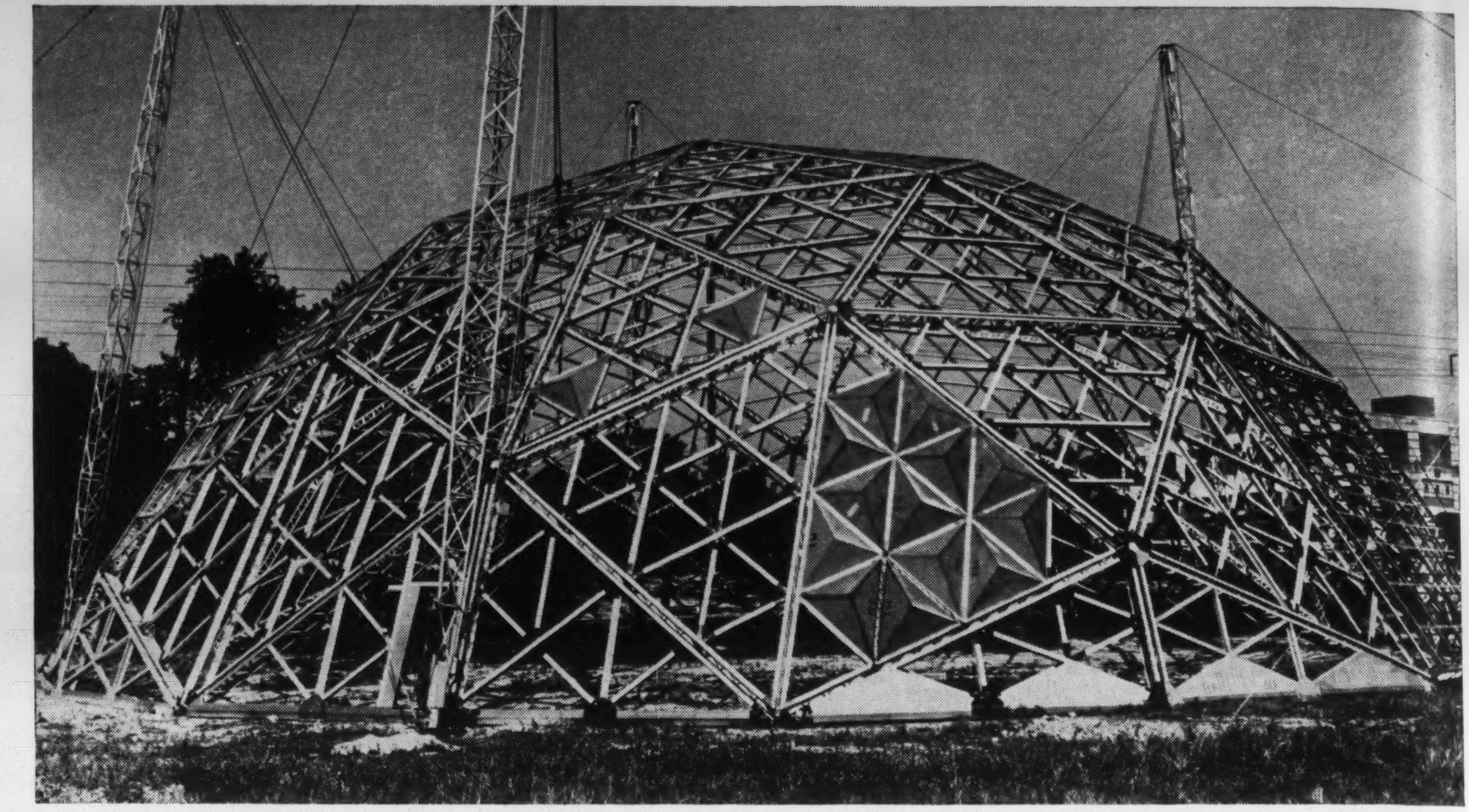
In all, 33 speakers, drawn from top levels of the nation's design engineers, will lead the discussions.

How to Register

This year's show carries a registration fee of $2, which can be paid any time during exhibition hours—12 noon to 6 p.m., May 20-23 (Monday through Thursday)—at the registration desk in the New York Coliseum. Advance registration cards may be obtained from Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N. Y.

Registration for the Conference can be made at the ASME desk in the main lobby of the Coliseum from 9:30 a.m. to 12:30 p.m., May 20-22; advance registration forms may be obtained from Clapp & Poliak. The Conference fee, $5 for ASME members and $10 for nonmembers, entitles the registrant to attend all Conference technical sessions, as well as the Design Engineering Show itself. In addition, each registrant will receive copies of all papers delivered at the Conference.

(Preview continued on p 21)



LARGEST CLEARSPAN DOME yet built with HETRON skin is this 117-foot geodesic dome, to be tested by U.S. Marine Corps as portable hangar for jet planes. Fabricator is Washington Aluminum Company, near Baltimore, Md.

How idea men are using HETRON® polyester

HETRON provides wind-resistant, fire-retardant skin for jet fighter hangar

Outstanding strength, excellent molding properties, the big *plus* of inherent fire retardance—these are a few of the properties of HETRON which are appealing to men with ideas in plastics.

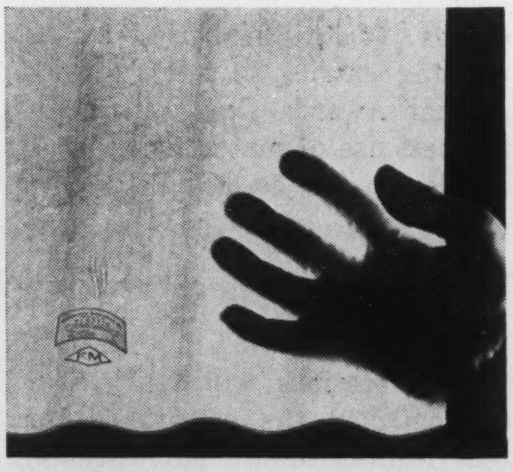
Like the builders of this geodesic dome to house jet fighters, for example. They needed a material which could withstand winds up to 150 mph. A material which would mold to critical tolerances. A material which would protect men and jet planes against fire. They chose HETRON.

Below are three more of hundreds of ways HETRON polyester resins are helping to bring new ideas to reality.

To discover how well HETRON can meet your particular design requirements, send for a complete data file on these resins. We'll also send a list of reputable fabricators working with HETRON.

Physical Property		Rigid Resins		Semi-rigid Resin
		HETRON 92	Avg. 10 Others	HETRON 32A
Flexural Strength, PSIx10³	Room Temp.	**38.6**	36.4	**41.8**
	180°F.	**25.0**	18.6	**23.5**
Flexural Modulus, PSIx10⁶	Room Temp.	**1.88**	1.61	**1.82**
	180°F.	**0.90**	0.79	**0.85**

1. When high flexurals are important. You get extra flexural strength with HETRON. Other advantages: unusually high impact strength; very high heat resistance; excellent tensile strength; very low water absorption.



2. When your product must meet building codes. When you need specific flame-spread data, you can get HETRON-based building materials with Underwriters' listing and label and Factory Mutual seal of approval.

3. For aircraft. Some HETRON resins, including semi-rigid HETRON 32A, are manufactured to meet MIL-R-7575A, Types I, II, and III.

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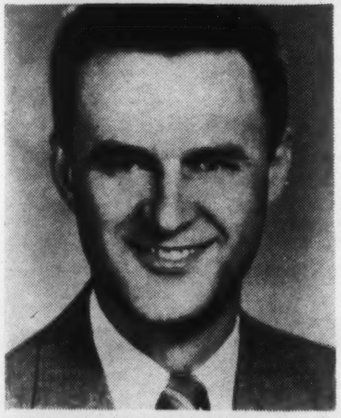
For more information, turn to Reader Service Card, Circle No. 634

Design Engineering Conference Program

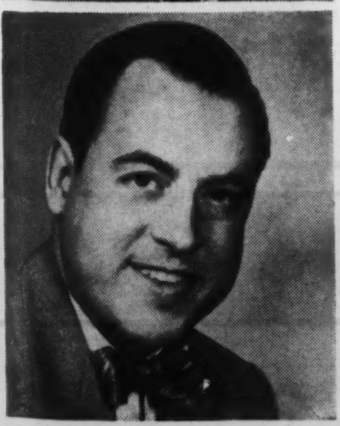
Speakers at Materials Sessions

C. R. Simcoe—*Metals*
New metals and alloys for high temperature use; new metals and alloys with high strength-weight ratios; honeycomb constructions; processes for improving properties. Materials: titanium, zirconium, molybdenum, alloys of aluminum and magnesium, and nodular iron. Processes: vacuum melting, casting, chem-milling, etc.



J. H. Koenig, E. J. Smoke—*Ceramics and Refractories*
Technical developments in the field of ceramics. Materials: refractories and refractory coatings, cermets, enamels, glass, dielectrics and porcelain and mechanical ceramics. Properties of materials and principal and potential areas of application will be covered.

Wyman Goss—*Plastics and Rubbers*
New applications for older materials; new materials; use of plastics in the automotive industry; use of plastics as a replacement for conventional materials of construction. Materials: vinyls, polystyrenes, phenolics, etc.



H. J. Reindl—*Coatings and Finishes*
Organic coatings: varnishes, enamels, epoxies, chlorosulfonated polyethylene (Hypalon). Metallic coatings: high vacuum metallized, electrically conductive, tungsten carbide, etc. Conversion coatings: oxide, phosphate, chromate, etc.

Program of Technical Sessions

Monday, May 20, 10:00 a.m.

Panel discussion on Procedures in Developing New Designs

Chairman and Moderator: GEORGE F. NORDENHOLT, editor, *Product Engineering*

Vice Chairman: CHARLES MARKS, member, New York and Patent Bar

Panel Members: T. M. BUTLER, director of engineering, Burroughs Corp.; MYRON S. CURTIS, engineering vice president, Warner & Swasey Co.; GEORGE F. HABACH, vice president, engineering, Worthington Corp.; ROBERT H. HOSE, Henry Dreyfus Associates; WILLIAM J. RUSSELL, vice president, engineering, Landers, Frary & Clark; and WALTER DORWIN TEAGUE, Walter Dorwin Teague Associates

Tuesday, May 21, 9:30 a.m.
(Three concurrent sessions)

Mechanical Session

Chairman: COLIN CARMICHAEL, editor, *Machine Design*

Vice Chairman: ROBERT M. CONKLIN, assistant manager, Mechanical Engineering Dept., Battelle Memorial Insitute

Speakers: "New Developments in Design and Application of Gearing," DARLE W. DUDLEY, advanced design engineer, gear engineering, General Electric Co.

"New Developments in Design and Application of Cams," HAROLD A. ROTHBART, professor, Dept. of Mechanical Engineering, City College of New York

Materials Session

Chairman: HENRY R. CLAUSER, editor, MATERIALS & METHODS

Vice Chairman: JOSEPH BONANNO, chief engineer, Lionel Corp.

Speakers: "Metallic Materials," C. R. SIMCOE, principal metallurgical engineer, Battelle Memorial Institute

"Ceramics and Refractory Materials," JOHN H. KOENIG, director, and EDWARD J. SMOKE, professor, School of Ceramics, Rutgers University

(continued on p 23)

FOUR PROCESSES THAT *turn ideas into reality*

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Segmented lines are depressed in black . . .
with roller embossed pattern. "Stop-roll" process
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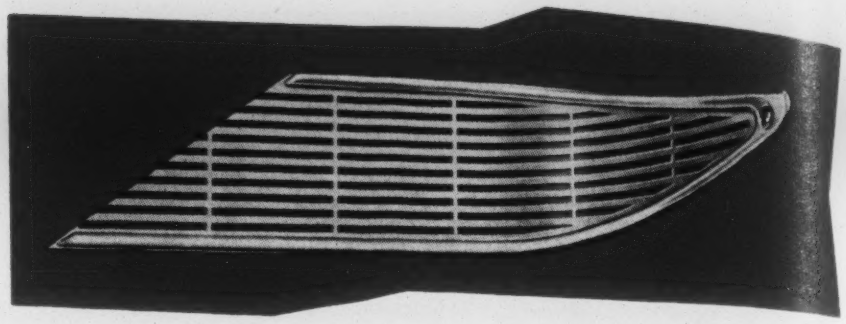

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Plate and lug one integral unit . . .
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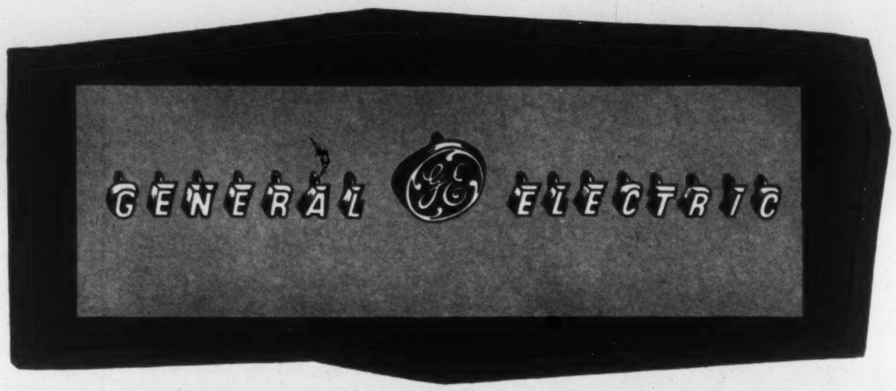
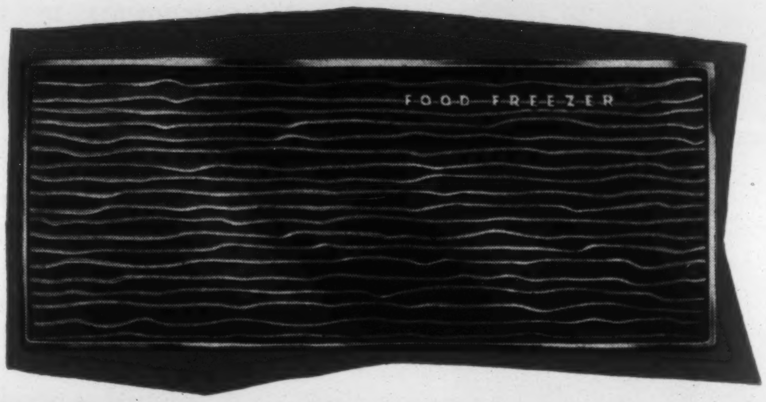


Embos
DEEP DIMENSIONAL EMBOSSING

Design and Identification.
Deep dimensional mechanical embossing on
color anodized aluminum and other metals
over which hard baked enamels
may be mask-sprayed.



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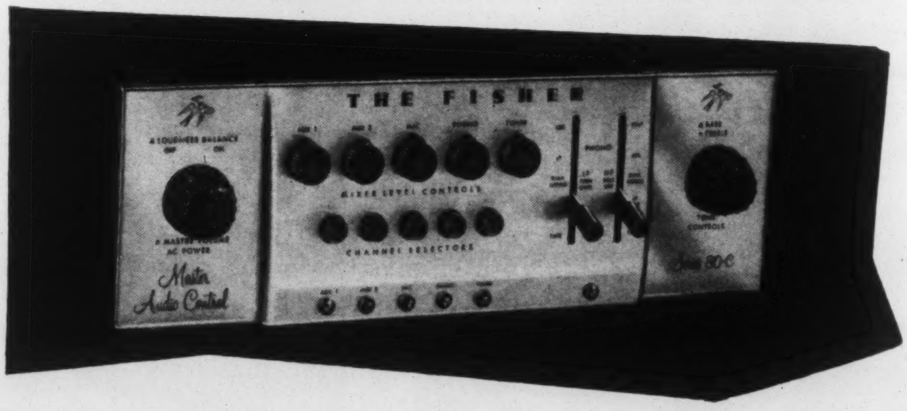

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Program of Technical Sessions—continued

Electrical Session

Chairman: FRANK J. OLIVER, editor, *Electrical Manufacturing*

Vice Chairman: WALTER T. BUHL, vice president-engineering and manufacturing, Leland Electric Co., Div. of American Machine and Foundry Co.

Speakers: "Selecting Motors with New NEMA Frame Sizes," EARL BARNES, assistant chief engineer, Reliance Electric & Engineering Co.

"Static Switching Devices," DR. ROBERT A. MATHIAS, assistant professor, Dept. of Electrical Engineering, Carnegie Institute of Technology

Wednesday, May 22, 9:30 a.m.
(Three concurrent sessions)

Mechanical Session

Chairman: HAROLD SIZER, director of design for machine tools, Brown & Sharpe Mfg. Co.

Vice Chairman: WILLIAM C. ALLEN, director, manufacturing and equipment engineering, Westinghouse Electric Co.

Speakers: "Designing for Easier Machining, Handling and Assembly," KURT O. TECH, vice president in charge of engineering, Cross Co.

"Hopper Feeding," FLOYD E. SMITH, president, Perry Equipment & Engineering Co.

Materials Session

Chairman: CARL MASSOPUST, director of research and development, Plastics Div., General American Transportation Corp.

Vice Chairman: DONALD R. MESERVE, products manager, organic coatings, Metal and Thermit Corp.

Speakers: "Plastics and Rubbers," WYMAN GOSS, manager, phenolics engineering, Chemical Materials Dept., General Electric Co.

"Coatings and Finishes," H. J. REINDL, supervisor, research and development, Finishes Section, Inland Mfg. Div., General Motors Corp.

Electrical Session

Chairman: DR. CUTHBERT C. HURD, director of automation research, International Business Machines Co.

Vice Chairman: JOHN RANDALL, assistant director, Manufacturing Engineering Office, Ford Motor Co.

Speakers: "Numerical Control for Machinery," CLAUDE D. COFFIN, senior electrical engineer, Warner & Swasey Co.

"Designing Machine Tools for Automatic Controls," C. G. SUNG, manager, mechanical Development Section, Research Laboratories Div., Bendix Aviation Corp.

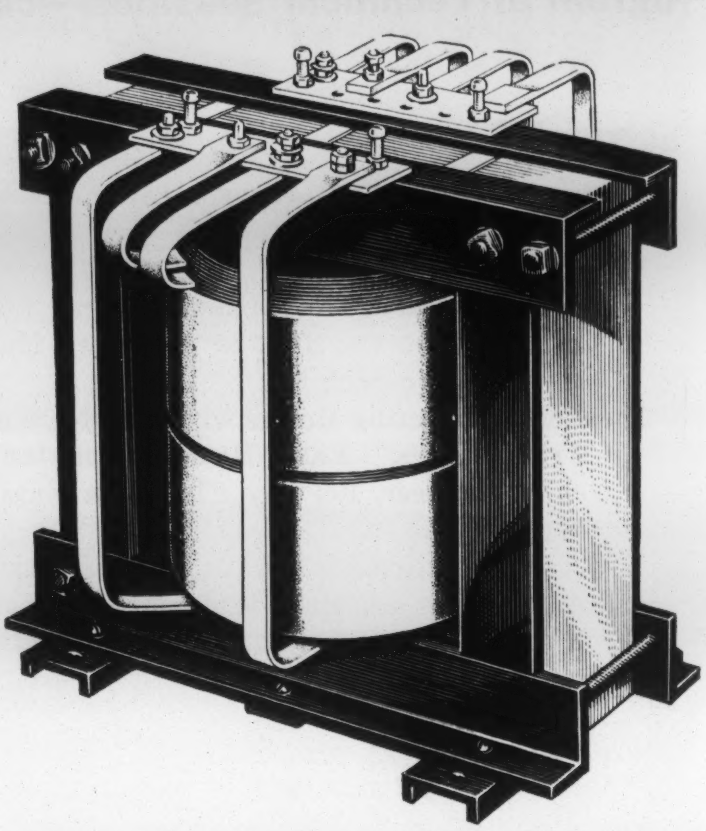
Exhibitors

2nd Annual Design Engineering Show

Acme Steel Co.	1132
Actuator Products Corp.	20
Acushnet Process Co.	1408
Aeroquip Corp.	727
Agastat Div., Elastic Stop Nut Corp. of America	115
Air-Maze Corp.	128
Albany Felt Co.	1415
Al-Fin Div., Fairchild Engine and Airplane Corp.	801, 802, 804
Alemite Div., Stewart-Warner Corp.	1232
Allegheny Ludlum Steel Corp.	1212
Louis Allis Co.	417, 419
Allis-Chalmers Mfg. Co.	1730
Alloy Products Corp.	32
Aluminum Co. of America	1114, 1118
Aluminum Extrusions Inc.	844
American Brass Co.	828
American Society of Mechanical Engineers	726
American Chain & Cable Co., Inc.	1517
American Machine & Foundry Co.:	
Leland Electric Co.	1313
Potter & Brumfield	121
Thompson-Bremer & Co.	842
American Nickeloid Co.	1307
American Plastics Corp.	111
AMP, Inc.	1834
Anchor Plastics Co., Inc.	319
Anderson & Sons, Inc.	1338, 1340, 1342
Anti-Corrosive Metal Products Co., Inc.	535
Applied Hydraulics	320
Armstrong Cork Co.	509, 511
Arwood Precision Casting Corp.	1243
Arrow-Hart & Hegeman Electric Co.	1831
Assembly Products, Inc.	1323
Associated Spring Corp.	205
Atkomatic Valve Co.	1807
Auburn Mfg. Co.	212
Automatic Switch Co.	1204
Automation	232
Automotive Industries	943
Aviation Developments, Inc.	625
Bakelite Co., a Div. of Union Carbide & Carbon Corp.	1005, 1009, 1013, 1019, 1023
Barber-Colman Co.	1329
Bart Mfg. Co.	218
Beaver Precision Products Co.	324
Beemer Engineering Co.	317
Bellows Co.	1643
Benton Harbor Engineering Works	728
Beryllium Corp.	1203
Boston Gear Works	206

(continued on p 25)

KEY to a revolution in electrical design—Reynolds Aluminum strip conductors



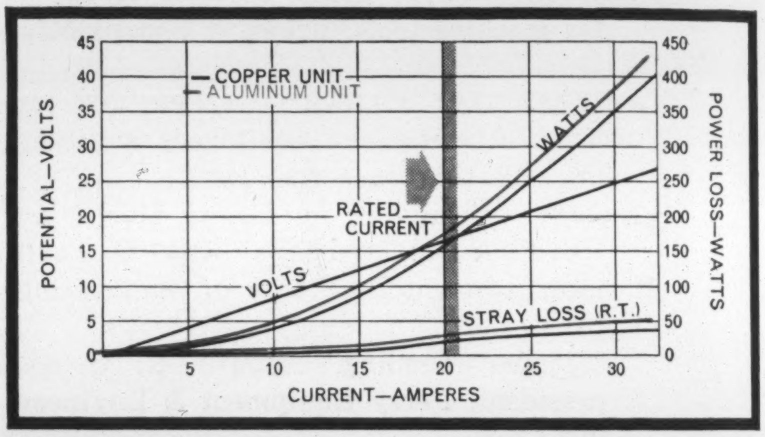
Aluminum Strip Conductor becomes its own insulation through anodizing—a process by which the non-conductive film of aluminum oxide, natural to aluminum, is deepened. This revolutionary conductor and its companion product, Reynolds Interleaved Strip Conductor, used with a very thin layer of insulation between windings, make many more aluminum advantages available to electrical design. Both conductors are now available as a result of Reynolds pioneering research.

Space and weight are saved in coils and transformers—and there's up to 50% savings in conductor material costs. Aluminum Strip Conductors provide added conductive area without increasing the space now required with copper wire. Space formerly taken up by insulation and voids in round wire windings is eliminated.

Heat dissipation is greatly improved because each coil winding is externally exposed and because of aluminum's high rate of heat transfer. Hot spots are eliminated, cooling ducts usually not needed. Electrical performance is increased because of lower average operating temperatures.

For all aluminum applications, advantages like this are available through Reynolds Design and Engineering Services. You can gain most from the strength, light weight and versatility of aluminum by asking these men to work with you on design problems. For their assistance call the Reynolds Office listed under "Aluminum" in your classified phone directory. Or write *Reynolds Metals Company, P.O. Box 1800-HM, Louisville 1, Kentucky.*

CONDUCTOR LOSS AND IMPEDANCE



Graph shows how electrical characteristics of a 10 kva copper wire wound transformer are virtually duplicated by a transformer with Reynolds Aluminum Strip Conductor wound in exactly the same physical space as conventional copper coils.

WEIGHT AND COST

COILS:	SQUARE COPPER DOUBLE GLASS INSULATION	ALUMINUM ANODIZED FILM INSULATION
CONDUCTOR SIZE		
PRIMARY	1—#6 GA	1—.008x3⅜
SECONDARY	2—#6 GA	2—.008x3⅜
TURNS:		
PRIMARY	2 COILS—84 TURNS	2 COILS—84 TURNS
SECONDARY	2 COILS—42 TURNS	2 COILS—42 TURNS
COIL WEIGHT	41 lbs	20 lbs
PRICE $/lb	$0.77	....
CONDUCTOR COST, $	$31.57	APPROX. 50%
CORE (SHELL TYPE)		
WEIGHT	132 lbs	132 lbs
CROSS-SECTIONAL AREA		
CENTER SECTION	14.625 in.^{2}	14.625 in.^{2}
YOKE	20 in.^{2}	20 in.^{2}

Here is a comparison of 10 kva—480/240—240/120 transformers of conventional copper design and with Reynolds Aluminum Strip Conductor in exactly the same physical space. Note that aluminum strip design saves approximately half the conductor cost and weight.

The Finest Products
Made with Aluminum
are made with
REYNOLDS ALUMINUM

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REYNOLDS ALUMINUM EXHIBIT
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Exhibitors—continued

W. H. Brady Co.	1827
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Brook Motor Co.	23
Charles Bruning Co., Inc.	1637
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Burndy Engineering Co., Inc.	1327
Camloc Fastener Corp.	840
Casting Engineers Inc.	839
Celanese Corp. of America	515, 517
Century Electric Co.	922
Cerro de Pasco Sales Corp.	1222
Chain Belt Co.	1819, 1821
Champion Rivet Co.	1041
Chicago-Allis Mfg. Corp.	518
Chicago Rawhide Mfg. Co.	616, 618
Chilton Co.	943
Cleveland Cap Screw Co.	919
Cleveland Designers & Consultants, Inc.	1043, 1045
Cleveland Graphite Bronze Co.	1829
Cleveland Hardware & Forging Co.	1836
Cleveland Worm & Gear Co.	222, 224
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Cobra Metal Hose Div., D. K. Mfg. Co.	202
Colonial Alloys Co.	1221
P. F. Collier & Son Corp.	713
Continental-Diamond Fibre Div., Budd Co., Inc.	738
Controlex Corp. of America	1430
Copper & Brass Research Assn.	1640
Coors Porcelain Co.	403
Corbin Cabinet Lock Div., American Hardware Corp.	1805
Crane Packing Co.	1042
Cross Engineering Co.	818
Cullman Wheel Co.	514
Cuno Engineering Corp.	1101
Curtiss-Wright Corp., Marquette Metal Products Div.	918
Curtiss-Wright Corp., Metals Processing Div.	1718
Cycledynamics, Inc.	1227
Dayton Rubber Co.	519, 521
Dearborn Glass Co.	1434
Detroit Controls Corp.	823
Diamond Chain Co.	1720
Diehl Mfg. Co.	132
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Dixon Corp.	321
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Dobeckmun Co.	426
Doehler-Jarvis Div., National Lead Co.	215
Douglas Fir Plywood Assn.	410
Dow Corning Corp.	406
Dow Chemical Co.	1503
Dresser Mfg. Div.	627
E. I. du Pont de Nemours & Co., Inc.	1014, 1018, 1022, 1113, 1119, 1123
Duff-Norton Co.	1704
Durakool-Hermaseal Companies, Inc.	1314
Durant Mfg. Co.	1141
Dynamic Gear Co.	939
Dzus Fastener Co., Inc.	711
Eastman Chemical Products, Inc.	221, 225
Eaton Mfg. Co., Reliance Div.	938, 940
Ebert Electronics Corp.	1426
Elastic Stop Nut Corp. of America	115, 117, 119
Electrical Coatings, Inc.	202
Electro Dynamic Div., General Dynamics Corp.	712
Electrical Manufacturing	929
Electro-Flex Heat, Inc.	303
Electro Metallurgical Co., Div. of Union Carbide & Carbon Corp.	1005, 1009, 1013, 1019, 1023
Electro-Snap Switch & Mfg. Co.	701
Elliott Mfg. Co.	719
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PLASTIC SANDWICH is easily cut for V-joint corners by mitering out corners, folding the sandwich panel together like a cardboard carton.

Unique sandwich construction paves way for

WORLD'S FIRST ALL-PLASTIC REFRIGERATOR CABINET

Here's a peek into your kitchen of tomorrow. It's a refrigerator recently introduced by Westinghouse, made completely of plastic.

Thanks to an unusual plastic sandwich technique, refrigerators will be just as strong, just as roomy, but much lighter. The sandwich is formed by Campco sheets laminated to a styrofoam core. This provides excellent insulation characteristics and offers tremendous flexibility in styling. The plastic sandwich means that tooling costs are much lower as compared to metal and makes it possible to produce a few thousand —or even a few hundred—units of one model economically.

Whatever your new product needs, you can count on Campco sheets. They're sturdy . . . lightweight . . . provide easy, low-cost forming. Decorated sheets—with photo-perfect designs, and simulated woodgrains, leather, lace, marble and other eye-appealing patterns—are ideal for a wide variety of products . . . from model toys to major appliances. Standard size sheets and film-rolls are available from stock at extra savings to you. For the full story, contact:

NEW PLASTIC REFRIGERATOR is lightweight, can be built as a wall-type or floor-type depending on customer's desires. Pilot model above, manufactured by Westinghouse Electric Corp., has 13 foot capacity.

CAMPCO *sheet and film*
a division of **Chicago Molded Products Corp.**
2722 Normandy Ave., Chicago 35, Illinois

RUBBER MODIFIED STYRENE • POLYETHYLENE • ACETATE • RIGID POLYETHYLENE
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Designing with BAKELITE Plastics
BRAND

- ***Durability plus quality appearance***
- ***Precise small parts that resist chemicals***
- ***New trick with a coating***

Here are three materials whose properties can help you solve design problems. One is a general-purpose phenolic plastic notable for its strength and appearance. Another is C-11, a tough plastic that resists staining. The third is an abrasion-resistant vinyl organosol, a coating with eye-appeal to match its proven durability. These are just a sample. The hundreds of BAKELITE Brand Plastics provide a tremendous range of properties to improve design, effect production economies. Remember: Bakelite Company offers larger resources, longer experience, and a greater variety and number of plastics—vinyls, epoxies, polyesters, phenolics, polyethylenes, styrenes, silicones and impact styrenes.

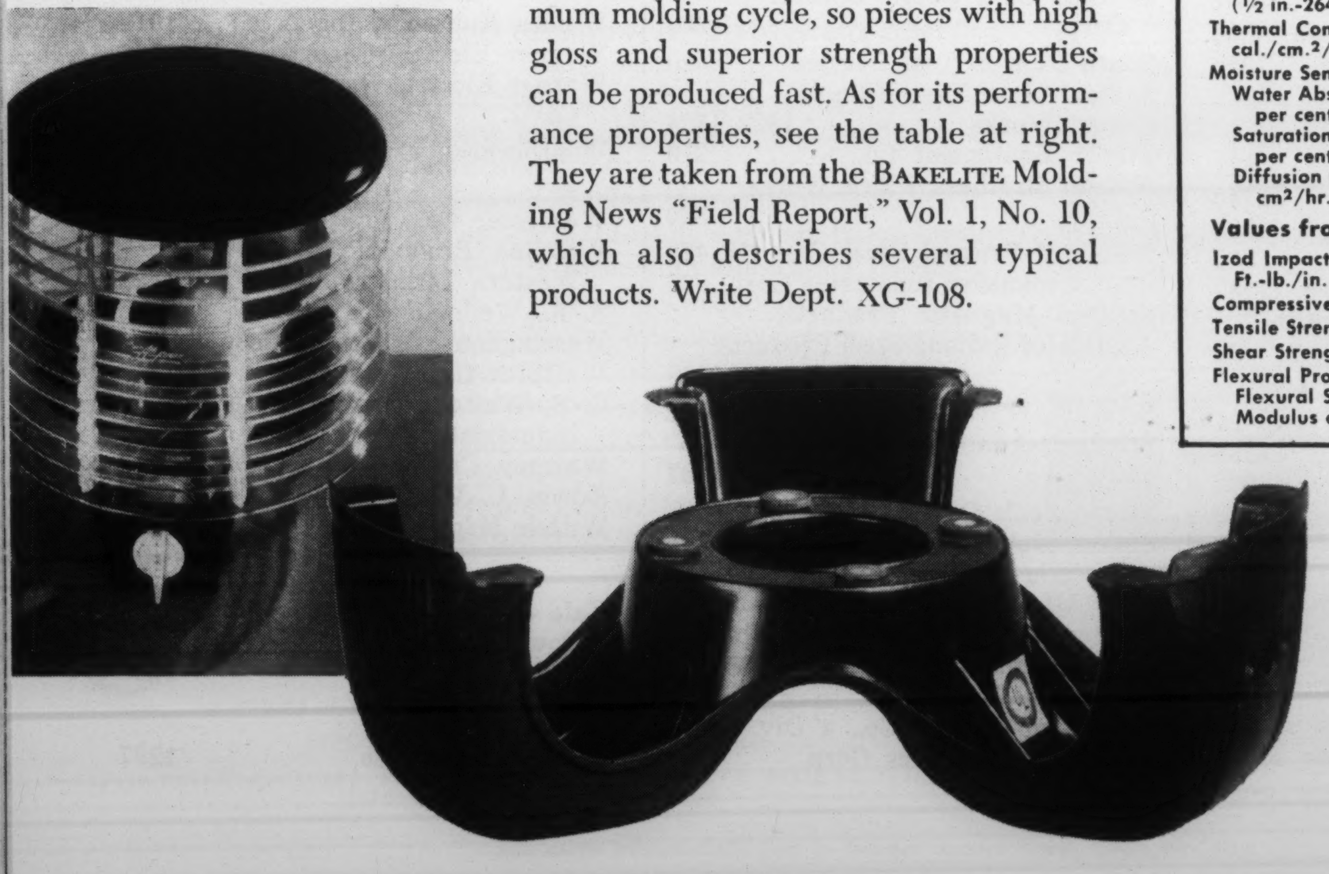
1

Designed for strength and beauty—with phenolic plastic above and below

Where the treatment is roughest—on the cover and base—the manufacturer of this electric hassock fan uses parts molded of BAKELITE Brand Phenolic Plastic BMG-5000. This material keeps its fine surface finish and rich color. It provides cleanly-molded details that point up the fan's quality construction, and aid in fast, faultless assembly. And, as a sales point, the manufacturer emphasizes that the cover and base of the fan will resist food acids, beverages, soaps, and detergents. BMG-5000 offers your plastics molder the best combination of molding and end-use properties. It requires a minimum molding cycle, so pieces with high gloss and superior strength properties can be produced fast. As for its performance properties, see the table at right. They are taken from the BAKELITE Molding News "Field Report," Vol. 1, No. 10, which also describes several typical products. Write Dept. XG-108.

BMG-5000
Typical Test Values

Values from Electrical Tests			
Dielectric Strength (D149-44) Short time, volts/mil	370		
Volume Resistivity (D257-54T) megohm-cm.	10^6		
	60 c.	1 kc.	1 mc.
Dielectric Constant (D150-54)	5.7	5.3	4.6
Dissipation Factor (D150-54)	0.07	0.04	0.03
Values from Miscellaneous Tests			
Molded Specific Gravity (D392-38)			
Black 25			1.34
Brown 15			1.36
Heat Distortion Temp. (648-45T), deg. F. (½ in.-264 psi)			330
Thermal Conductivity cal./cm.^{2}/sec./deg.C/cm.			5×10^{-4}
Moisture Sensitivity:			
Water Absorption (D570-54T) per cent wt. gain			.45
Saturation Constant (WC-78-B-2), per cent			8.0
Diffusion Constant (WC-78-E), cm^2/hr.			1.3×10^{-5}
Values from Mechanical Tests			
Izod Impact Strength (D256-54T) Ft.-lb./in. of notch			0.30
Compressive Strength (D695-54T), psi			34,000
Tensile Strength (D651-48) (⅛"), psi			8,400
Shear Strength (D732-46) (⅛"), psi			13,000
Flexural Properties (D790-49T):			
Flexural Strength, psi			10,000
Modulus of Elasticity in Flexure, psi			1×10^6



This "Air Flight" circulator has both cover and base molded of BAKELITE Phenolic Plastic BMG-5000. Note particularly the elaborate one-piece molded construction of the base.

ONE POINT OF VIEW

Awards entries: some good, many not so good

The first annual MATERIALS & METHODS Awards Competition for the Best Use of Materials in Product Design is now over, and it is with a great deal of pleasure that we announce the winners and present their entries in this issue. We believe that you will find reading the special section (p 147) devoted to the winning entries both interesting and stimulating.

Over 150 entries were received, and they came from most segments of the manufacturing industries. The products ranged from small parts or components to large assemblies. Because the entries represent such a wide cross section of product design, this Awards Competition afforded a good opportunity to evaluate the way in which our engineers and designers are selecting and using engineering materials.

We believe the judges' critiques (p 149), when taken together, provide a good appraisal of these current materials selection practices and trends.

The good side

The judges had a number of good things to say about the entries, but they also voiced some reservations. On the one hand, they observed that most of the winning entries reflected sound and progressive use of materials. The first award winner is an excellent example. As one of the judges pointed out, the use of plastics sandwich construction for a refrigerator is a bold new departure in the use of materials, which may have tremendous economic consequences. Among the other award winners, such as the union check valve and the sanitary fixture, you will find solutions to materials problems that are brilliant and imaginative and that also may have far-reaching influence on many future designs.

Common to all of the winning entries was the use of the engineering approach to find the optimum materials for the application. This approach involved a thorough analysis of all the service requirements, followed by a step-by-step evaluation of the numerous materials that might be suitable. The engineering approach was particularly evident in several entries where the design not only took advantage of the desirable characteristics of the materials but also minimized the effects of the material's unfavorable qualities.

The poor side

On the other hand, many of the nonwinning entries revealed a rather pedestrian approach to materials selection problems. In a number of cases a material was selected without a thorough evaluation of alternate possibilities. And closely related to this practice was the failure to take into account *all* of the service requirements that the material (and product) would have to meet.

Another criticism applicable to many of the entries was the failure in the redesign of a product to take advantage of the new materials that have become available since the product was originally designed.

The balance

What conclusions can we draw from this critique of the competition entries? There are several, but perhaps the one that expresses the over-all impression of the judges best is the observation made by one of them at the end of the judging session: "I was very very much encouraged by the high quality of many of the entries and by the well-thought-out solutions to the materials selection problems . . . but there is still a lot of room for improvement."

U.S. AIR FORCE
27995
CONVAIR

Supersonic interceptor *shown here is a Convair F-102 delta wing.*

Aircraft Materials—

Present and Future

The aircraft and power plant designer, by working on the frontiers of materials knowledge, has been a primary force in new materials developments. Here is a summary of the problems that designers face today and how they may be solved.

Airframe Materials

With the successful achievement of supersonic flight, the environments of heat, corrosion, radiation and high altitude have replaced the sonic barrier as our envelope of flight. To achieve air weapon supremacy, it is necessary to provide lightweight, reliable structures that will withstand the extreme punishment of these environments. For any weapon design, the key to progress will be the materials of construction.

High temperatures

At speeds of 1650 mph and above an airframe is subject to severe heating from three sources: aerodynamic friction, the power plant, and internal mechanical and electrical equipment. During sustained operation at 1650 mph the temperature due to aerodynamic heating approaches 400 F. It has been estimated that portions of a missile reentering the earth's atmosphere might reach a short-time temperature of 10,000 F. There are no known materials that remain solid at such temperatures.

At high temperatures certain physical properties of a material are of prime importance. Significant properties include: 1) thermal conductivity, since it determines the ability of a material to conduct heat away from the surface; 2) heat capacity, since it determines the capacity of a material to absorb a given heat input per unit mass with a minimum rise in temperature; and 3) melting point. Oxidation resistance is also extremely important.

Aluminum and magnesium alloys—The need for heat resistant materials is demonstrated by the marked drop in the strength-to-weight ratios of aluminum and magnesium alloys with increasing temperatures. These materials, however, must not be discarded as being unsuitable for the supersonic airframe. Promising magnesium alloys have been produced by pellet extrusion and by the addition of rare earths. Sintered aluminum powder materials also deserve further study. It remains to be seen whether the alloys resulting from these or other ingenious approaches will be able to compete at high temperatures with titanium alloys and the precipitation hardening stainless steels.

Titanium alloys and stainless steel—Only a few materials, such as titanium alloys and stainless steels, retain a reasonable degree of strength in the range of 300 to 800 F. Many attempts have been made to compare these materials. One analysis and set of curves will show the superiority of titanium; another analysis will show the opposite. At this stage of development neither can be proclaimed to be superior, but in the range of 300 to 800 F it appears that some of the recently developed titanium alloys, such as 6Al-4V (containing 6 aluminum, 4% vanadium), may have a slightly better strength-to-weight ratio than stainless steels such as 17-7 PH. Above 800 F, however, the steel alloys become increasingly superior to titanium.

There is an urgent need for improvement in the quality control, fabrication techniques and elevated temperature properties of titanium alloys. Also, thin gage sheet lacks uniformity, forgings are susceptible to embrittlement, and weldability is still a problem. Over 10,000 lb of titanium is being used in the Navaho missile, including about 4300 lb of 0.060-in. sheet. This heavy gage sheet is being used with a considerable weight penalty because light gage weldable sheet is not available. Precipitation hardening titanium alloys now under development may help solve these problems.

Precipitation hardening stainless steels are definitely competitive with titanium alloys from 300 to 1000 F. These alloys possess slightly poorer strength-to-weight ratios than titanium alloys, but are more easily fabricated. At present, requirements exist for improved quality and uniformity of production material, higher strengths, and decreased susceptibility to stress corrosion cracking.

Other potential materials for service to 1000 F include the martensitic stainless steels and coated lean alloy steels. The martensitic steels possess a promising strength-to-weight ratio; however, sheet formability of the materials is still a problem.

Protective coatings—Protective coatings combining good mechanical strength with oxidation and erosion resistance are a prime requirement. Development of ceramic coatings with these properties would permit the use of many materials such as molybdenum (see "Protecting Molybdenum at High Temperatures," M&M, Dec '56, p 84) up to 2500 F or higher.

Fatigue—Research in fatigue appears to be lagging behind materials development. At a recent two day symposium on fatigue, almost all of the papers presented dealt with aluminum alloys and riveted construction. Little mention was made of titanium, plastics, ceramics, bonded constructions, fatigue at high temperatures or the effects of high noise loading.

Continued research into the nature and mechanisms of fatigue is warranted. Superimposition of noise and high temperatures on the normal vibrational causes of fatigue has greatly intensified the problem. This fact is demonstrated by the occurrence of noise fatigue on such aircraft as the F-101 and the B-52. Some progress has been made by using high dampening materials such as plastics and adhesive bonded sandwich constructions.

About This Article

The satisfactory performance of aircraft at very high speeds and altitudes is dependent on the development of improved engineering materials. Members of the Air Research and Development Command, USAF, were invited to the 25th Annual Meeting of the Institute of Aeronautical Sciences in New York early this year to summarize the present status and the future of aircraft materials. Seven papers in all were presented by members of the ARDC. Two of the most significant papers are summarized here. The section on airframe materials is based on a paper by Major Frederick C. Krug; the section on aircraft power plant materials on a paper by Lt. Col. Rodney A. Jones. Major Krug and Lt. Col. Jones are both with the Equipment and Materials Div. of ARDC. For a summary of the other papers on aircraft materials, see What's New In Materials, p 214.

Creep—Creep can be defined as the slow extension or contraction of a solid when subjected to a steady load. The fundamentals of creep are still not clearly known and further research is required. Creep is accelerated by long time exposure under load at elevated temperatures and the phenomenon can produce failure at stresses well below safe operating loads. As shown in Fig 1, the use of titanium alloys in some applications may be limited to only 700 F because of the material's drop in creep strength above this temperature.

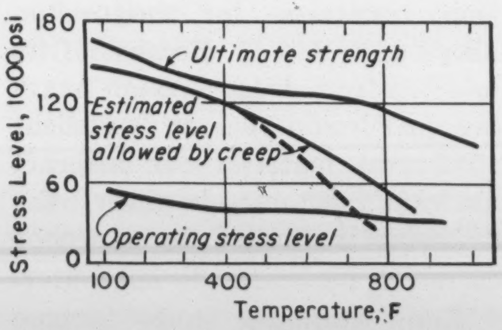


Fig 1—*Creep strength of 6Al-4V titanium alloy. (Assumed criterion: 0.002 in. per in. permanent deformation after 500 hr.)*

Stiffness—The factors of column action or plate buckling must be considered when designing compressively loaded structures. Column action is dependent upon the modulus of elasticity and density of a material. Requirements exist, therefore, for materials with higher modulii and lower densities even if the strength-to-weight ratio is not improved. These materials must be capable of maintaining their rigidity above 400 F.

Sandwich constructions—The expected temperature limitations of present and future sandwich type constructions are summarized in Fig 2. A technical breakthrough to produce a stiff, lightweight material useful in the range of 1000 to 1400 F would be invaluable for future airframe designs. Present development of sandwich constructions is centered principally around the foamed core and honeycomb core types. Although other types may be more structurally efficient, the foamed-in-place sandwich construction offers much promise for reducing weight and fabricating time and expense.

Honeycomb structures hold great potential for increasing the efficiency of structures in compression. Present requirements call for the development of suitable bonding methods for large curved panels, and for nondestructive test methods to assess the quality of fabricated panels.

The present strength capabilities of high polymer adhesives used in bonding sandwich structures are shown in Fig 3 as a function of time and temperature. The Air Research and Development Command is currently concentrating its work on epoxy, silicone and inorganic adhesives suitable for service at 500 F. Long range goals call for adhesives suitable for short time service at

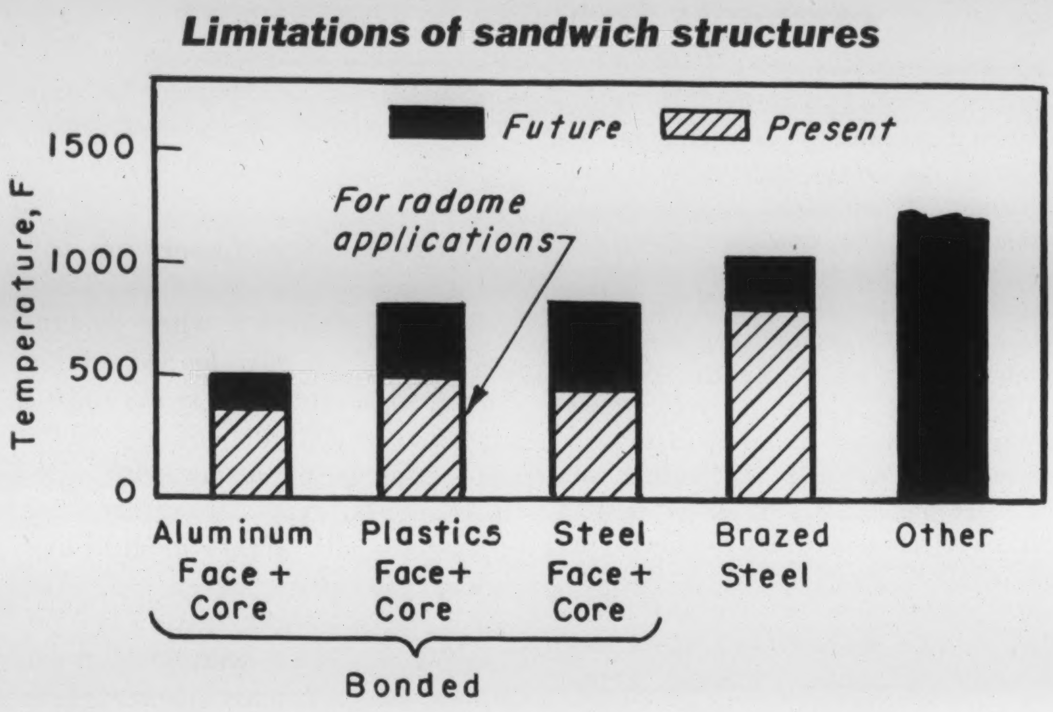


***Fig 2**—Temperature limitations of sandwich type constructions.*

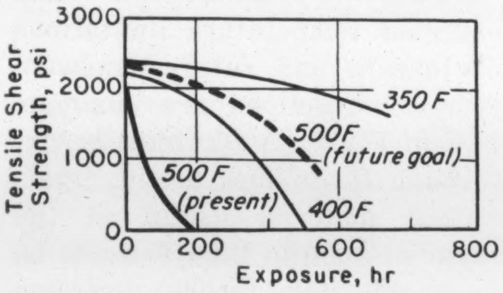


***Fig 3**—Effect of exposure time at temperature on adhesive strength of bonded sandwich constructions.*

1000 F (about Mach 3.5). Brazing is useful to 800 F, but problems are presented by the corrosive action of the braze and flux materials.

Landing gear materials—Requirements call for a high strength-to-weight material. Steels with ultimate tensile strengths of 220,000 to 300,000 psi are being studied thoroughly. One aircraft company has realized a 15% weight saving by using SAE 4340 steel which after 400 hr at 400 F has an ultimate tensile strength of 252,000 psi and an ultimate yield strength of 175,000 psi.

The medium carbon, low alloy, hardening steels begin to lose their strength at 500 to 600 F. They are usually protected against corrosion by electroplating; however, this can lead to hydrogen embrittlement. Other problems associated with these materials are variability in the properties of production heats, poor transverse ductility, and low fatigue strength in comparison to tensile strength. Also, it is difficult to produce a weld comparable in strength to the base material.

Transparent materials—Because of the thermal breakdown of interlayer materials, presently used laminated plastics and glasses are limited to service below 250 F. Monolithic glass can be used to near 800 F, but it is limited by its high weight, brittleness, susceptibility to thermal shock and poor shatter resistance. Lightweight oriented plastics hold some promise for service up to 450 F. Also, fused silica has potential for service to 1700 F.

Corrosion

One of the main deterrents to the wider use of magnesium alloys has been the lack of suitable protective treatments. Recent research has produced epoxide-polyamide and silicone-alkyd coatings that provide excellent corrosion resistance for magnesium alloys up to 500 F. Because of its low neutron cross section magnesium would be an excellent structural material for aircraft nuclear reactors; however, the material is limited by its poor corrosion resistance to hot water.

Many stainless steels become sensitive to intergranular corrosion above 800 F. Also, stress corrosion cracking is evident in the copper bearing aluminum alloys at high temperatures.

The problem of corrosion today is being intensified by the use of high energy propellants. Titanium alloys, for example, are subject to severe, almost explosive, stress corrosion when exposed to fuming nitric acid—a condition produced by the rapid oxidation of finely divided titanium particles. Preliminary research indicates that such particles may not form when the water content of fuming nitric is slightly greater than 1%.

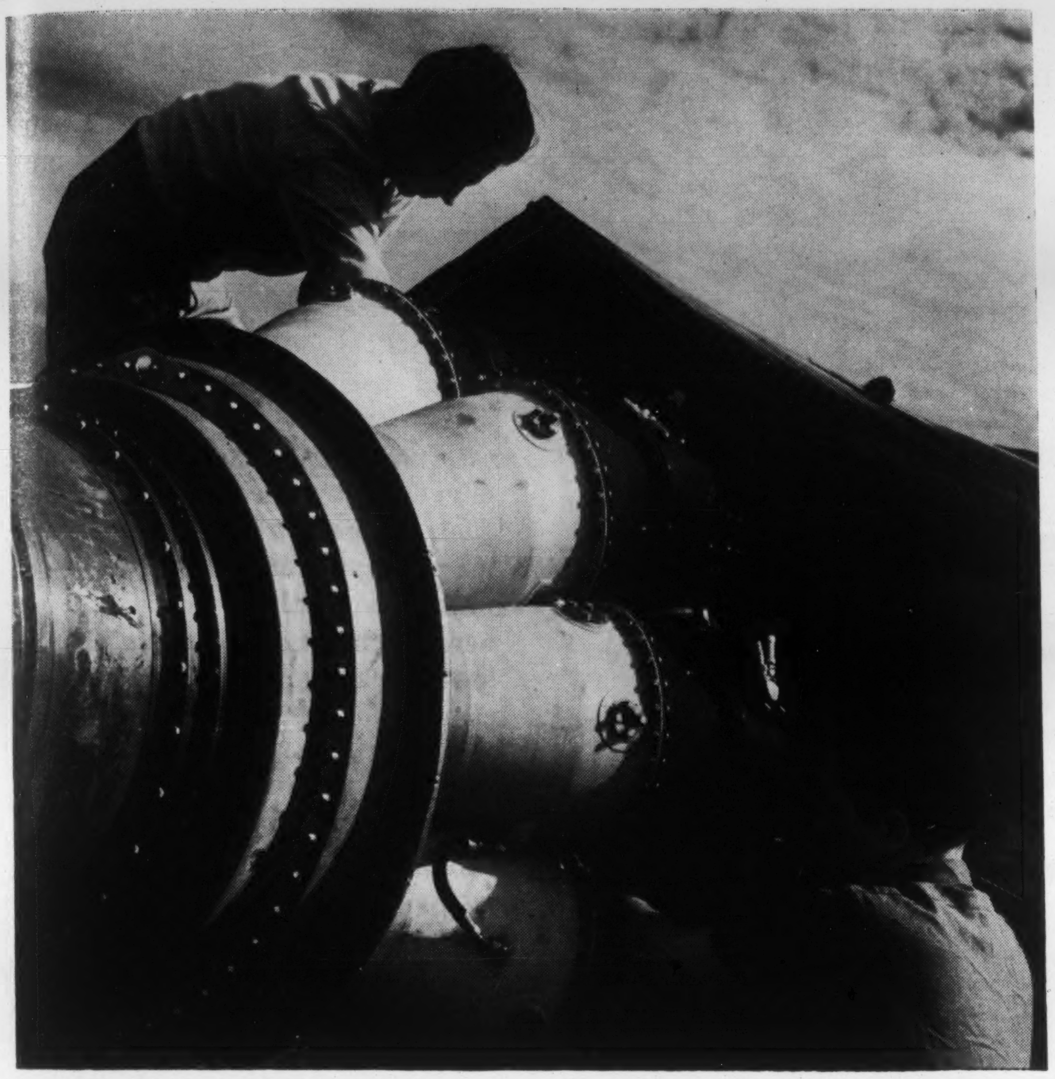
Exhaust vapors and residues from rockets also create rapid and severe corrosion. If launching mechanisms are placed within the fuselage or in retractable launchers, corrosive materials can accumulate in parts of the fuselage and wings. Standard protective organic coatings are inadequate, since they are destroyed by the heat and erosive particles of the rocket exhaust. Consequently, there is an urgent need for protective coatings and compartment sealing materials that can resist such attack.

Radiation

The effects of radiation on airframe materials must be considered when using nuclear propulsion systems. Results to date show some degree of degradation in virtually all materials. Some metals exhibit property changes similar to those produced by cold work. Radiation produces a considerable increase in the hardness of annealed metals, but has little effect on the hardness of hardened metals.

Plastics, such as polyester laminates and acrylic sheet, are severely damaged. One notable exception is the marked increase in heat resistance produced in polyethylene after irradiation.

Another aspect of radiation is thermal reflectance. At high altitudes and close proximity to nuclear explosions, it is extremely desirable to use materials that reflect a high percentage of incident radiation. This factor will have to be considered in future applications.



Jet engine *(Pratt & Whitney J-42) is installed in a Grumman F9F2.*

Power Plant Materials

Turbojet engines

In conventional turbojet engines total compression ratios of 10 or 12 to 1 are generally encountered and compressor discharge temperatures are usually below 700 F. A kerosene type fuel is burned in the combustion cans with an admixture of air, and temperature at the turbine inlet is about 1600 F. Temperatures and the conditions of operation are expected to be much more severe in future supersonic turbojet engine designs. The present temperature limitations and possible heat ranges of future engine materials are summarized in Fig 4 on the next page.

Compressor sections — Current designs utilize aluminum alloys where temperatures are below 300 F, and ferritic steel alloys in hotter areas. Titanium alloys are being used for some compressor blades and rotors, and magnesium alloys for compressor casings. Reinforced plastics are also being used experimentally.

Compressor sections for supersonic engines are considerably harder to design because of their high inlet temperatures and because their outlet temperatures approach present turbine operating temperatures. Lightweight reinforced plastics with excellent fatigue life offer potential to 500 F and above. However, their application has been restricted because of erosion problems, low stiffness moduli and lack of experience in working with the materials.

Titanium and steel alloys appear promising for use to 900 and 1100 F, respectively. From a long range standpoint, the possibilities of lightweight titanium alloys have just been scratched; however, problems of creep and oxygen pickup above red heat still must be solved, and considerable development and testing are still necessary.

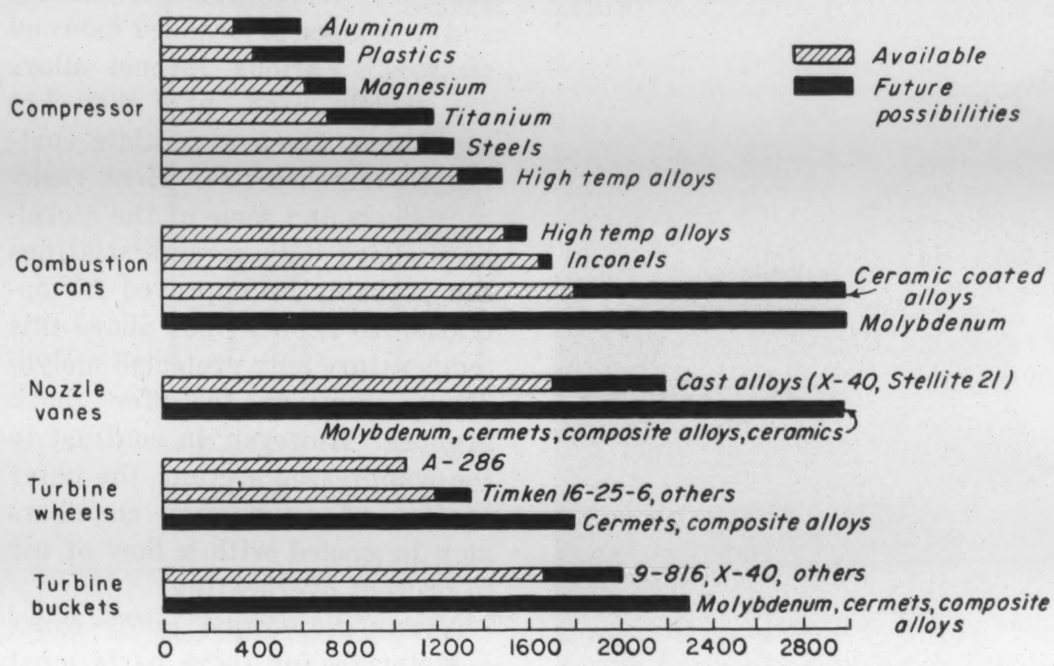
Combustion chambers—Materials for turbojet combustion chambers must possess high temperature strength, oxidation resistance, weldability, formability and resistance to localized thermal stresses. Various Inconel alloys are widely used, and they are sometimes given a ceramic coating to increase life. Heat resistant steels and some of the nickel-base alloys with ceramic coatings can probably be improved for operation to 2000 F, but above this temperature only protected molybdenum appears to offer much promise. However, in contrast to the compressor section, the outer surface of combustion chambers may be cooled with a flow of air to prevent overheating.

Nozzle diaphragm guide vanes—Materials for these parts must have high resistance to thermal shock, impact, erosion and oxidation. Most nozzle vanes are made from cast X-40, Stellite 21 or similar materials. Though some improvement in these materials is possible, it appears that any major increases in operational temperatures must come from such materials as protected molybdenum, cermets, composite metal alloys and possibly ceramics.

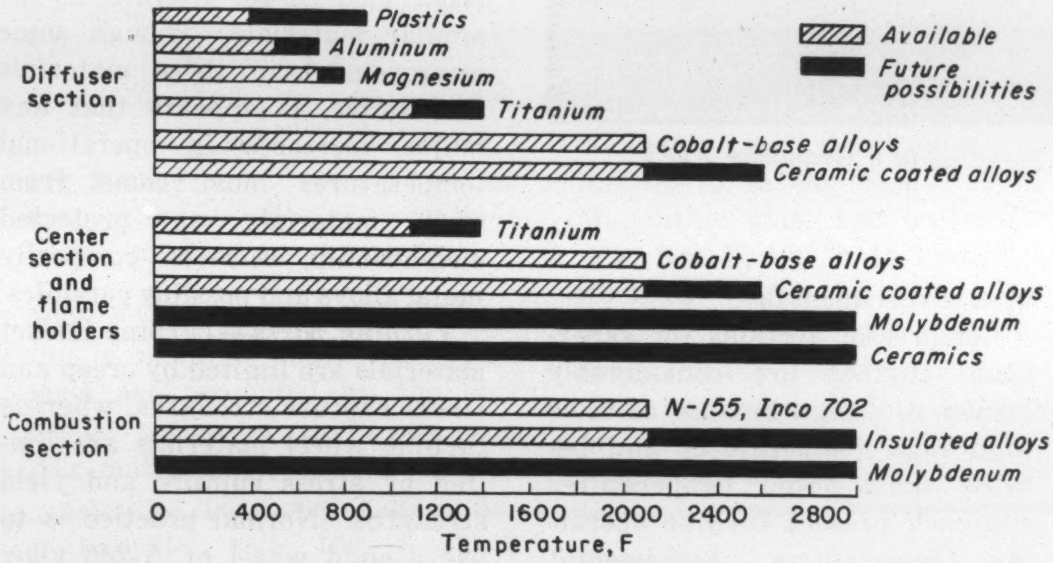
Turbine parts—Turbine bucket materials are limited by creep and stress rupture strengths, whereas turbine wheel materials are limited by stress rupture and yield strengths. Normal practice is to use a solid wheel of A-286 alloy or a composite of an SAE 4340 hub and a Timken 16-25-6 rim. Operating temperatures range from 1200 F at the rim down to 500 F at the hub. Turbine buckets of cast materials similar to X-40 or wrought materials similar to S-816 are used at temperatures up to 1650 F.

Limited but important improvements in the above alloys appear possible. The attractiveness of molybdenum for turbine parts is diminished by its high density and need for oxidation protection. Cermets or composite metal alloys appear to offer the most interesting possibilities for high temperature turbines in spite of the fact that engine tests have not been

Temperature limitations of present and future materials . . .



. . . for turbojet engine components.



. . . for ramjet engine components.

100% successful.

Exhaust sections — Requirements of tail pipe and afterburner materials are similar to those of the ramjet combustion section materials described below.

Ramjet engines

The choice of materials for ramjets is subject to wide variation from design to design. Though materials requirements are similar to those of the nonrotating parts of turbojets, they are based on short time, limited re-use operation. It is expected, however, that future operating times will be on the order of 50 to 100 hr.

Present and future requirements for ramjet materials are summarized in Fig 5. Current engine designs are limited by the maximum operating temperature limits of metal combustion chambers. Insulating ceramic coatings and molybdenum alloys hold some promise of withstanding temperatures up to 3000 F. Ceramic and cermet materials with good oxidation resistance offer possibilities for future flame holder designs.

Rocket engines

The basic problems of rocket engine materials are those associated with high pressures and temperatures, corrosive atmospheres and chemical and mechanical erosion. These problems are further complicated by such factors as: the type of fuel and oxidizer, whether a liquid or solid fuel is used and the duration and severity of operation.

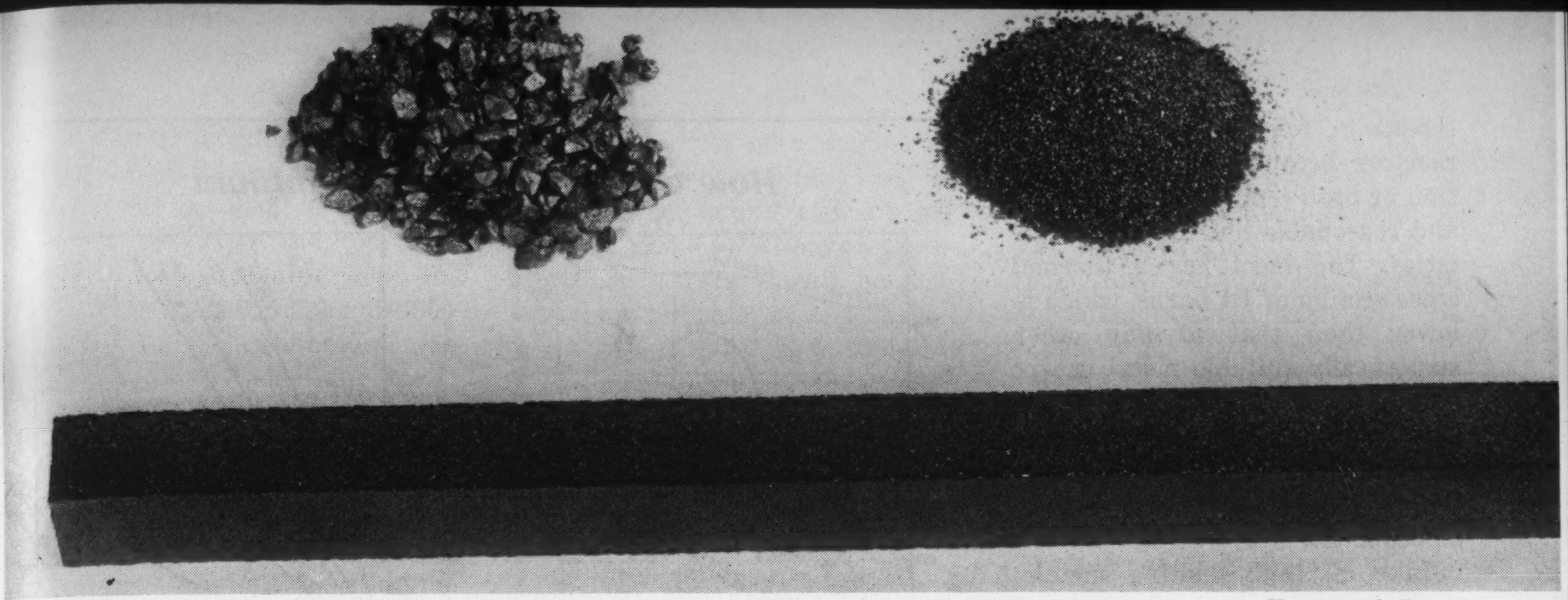
Regenerative cooling of superalloy parts has proved very successful with engines using liquid oxygen, nitric acid, alcohol or jet fuels. Some trouble in engines using regenerative cooling is expected with the introduction of new, higher energy fuels having lower heat capacities and higher combustion temperatures. Ceramic coatings or linings in conjunction with improved cooling designs may be the solution to this problem.

Nuclear power plants

Nuclear power plants possess all of the problems and requirements of conventional power plants plus those of a radiation environment. With a nuclear powered turbojet engine, the amount of radiation received by engine materials will depend on their location with respect to the reactor, the amount of shielding, and the type of cycle used.

On the basis of existing information, it appears that no serious problem will exist in the case of metals. However, organic materials such as plastics and elastomers are severely damaged at relatively low dosages, and more radiation resistance will be required.

Induced radioactivity may be a serious problem in engines requiring maintenance and overhaul. The solution may be to develop engine materials containing no elements that become radioactive after exposure to radiation for long periods. Induced radioactivity will not be as critical for missile engines. If operational life is short the problems of radiation will probably be limited to electrical and electronic materials. Considerable research is required to keep shielding weight within reasonable limits.



Kennametal, Inc.

Some basic forms *of columbium: arc melted electrode (99.5% Co), granules and powder.*

Columbium and Its Uses

Discovery of large reserves of columbium ores greatly expands the potential usefulness of this metal, particularly in:

- *Nuclear energy installations*
- *High temperature equipment*

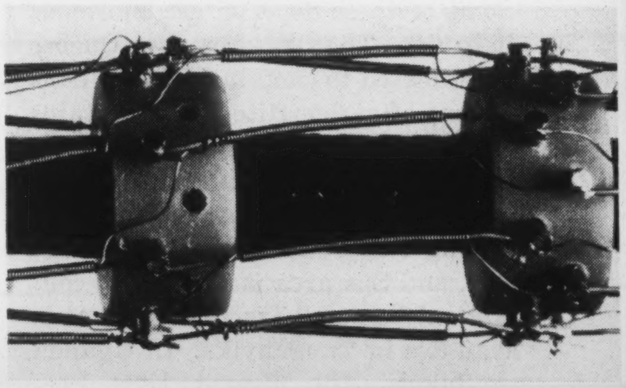
G. L. Miller, *Director of Research, Murex, Ltd.*

■ Increased interest in columbium (called niobium by chemists), a metal that has been in production for many years, results from the discovery that the metal has possibilities in the nuclear and high temperature fields and is in ample supply for any reasonable requirement. Actual reserves of columbium in North America exceed the combined total known reserves of nickel and molybdenum. Thus, instead of being a scarce metal of limited potential use, columbium has become a metal with great potentialities.

In high temperature applications, convential heat resisting alloys have nearly reached the limits of their possibilities. Consequently, properties of the high melting metals — molybdenum, tungsten, tantalum and columbium—are being explored. Molybdenum has been considered very promising for high temperature applications because small alloying additions improve its high temperature strength. However, no alloys of molybdenum have been produced that combine high temperature strength with suitable oxidation resistance, and it is necessary to resort to coatings as a method of protection. Although some coatings are good, none entirely satisfies the severe service requirements—oxidation, erosion, impact, thermal shock and others—that must be met.

The properties of columbium indicate its promise as a high temperature material. The metal has a medium density (0.31 lb per cu in.). Its strength at high temperatures is excellent, and unlike molybdenum, columbium retains its ductility after heating to elevated temperatures. Although poor when compared with conventional heat resisting alloys, columbium has better oxidation resistance than molybdenum and, in addition, does not suffer catastrophic failure by oxidation at high temperatures. Thus, columbium can be protected by a coating with the assurance that if the coating fails, a reasonable time would elapse before failure of the part. Also, there is reason to believe that alloying may produce a material with satisfactory oxidation resistance.

Columbium is particularly in-



Massachusetts Institute of Technology

A new application. *Insulated columbium wire is used as a control winding around a straight section of tantalum wire in the Cryotron, an electronic component that operates at —452 F.*

teresting for fast or thermal reactors because of its combination of high temperature strength and reasonable nuclear characteristics. The meal has a thermal cross section of 1.1 barns, which is lower than that of any other structurally suitable metal except aluminum, zirconium and beryllium. It is resistant to corrosion by liquid sodium and bismuth, metals that have been suggested as coolants.

Like all high melting metals, columbium is reactive toward the common gases—oxygen, nitrogen and hydrogen—but, in general, it is easier to fabricate than the other high melting metals.

Properties

The properties of columbium are influenced greatly by gas absorbed during processing. An indication of these effects is given in Fig. 1. Strength and hardness increase and ductility decreases greatly as the oxygen content increases. Working properties are also affected. For good fabrication properties, the oxygen content must be held below 0.03%.

How oxygen affects columbium

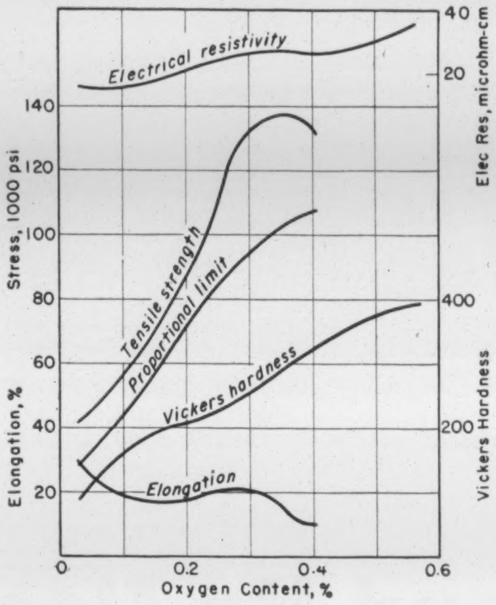


Fig 1—*Effect of oxygen on mechanical and electrical properties.*

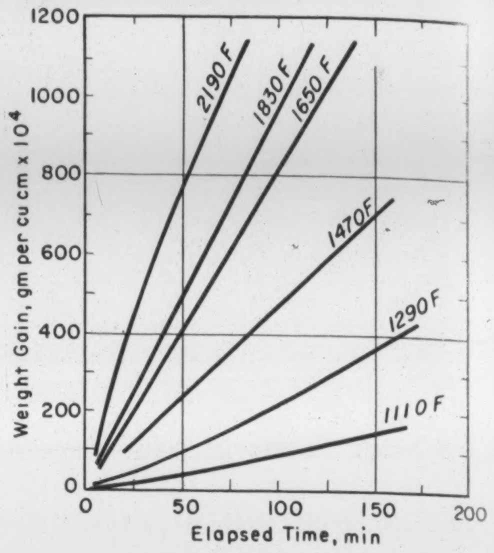


Fig 2—*Rates of oxidation in air at various temperatures.*

Availability

The year 1954 saw a change from acute shortage to abundant supply of columbium minerals, about 10 million pounds of concentrates being produced in that year. The United States imported over 80% of this total, Nigeria supplying nearly 70% and the Belgian Congo 15% of U.S. imports.

Deposits have been located in Nigeria, Uganda, Kenya and Canada. Some of these deposits are enormous in extent. The Oka area near Quebec is estimated to contain many millions of tons of carbonatite which contains 0.1 to 0.5% columbium oxide (Cb_2O_5). In Panda Hill (Mbeya), Tanganyika, proved reserves of carbonatite containing 0.31% Cb_2O_5 are 9½ million tons, and this area is thought to contain only a small fraction of what is available in Tanganyika. In Uganda at Sukulu Hill, Tororo, East Province, there is another enormous carbonatite deposit proved to contain at least 130 million tons (and said to contain about another 70 million tons) averaging 0.2% Cb_2O_5.

Physical properties—Thermal expansion and electrical resistivity of columbium are slightly higher than for tantalum, and thermal conductivity is slightly lower. However, the density of columbium is only half that of tantalum, a distinct advantage in applications for which both are suitable. Effect of temperature on physical properties is shown in Table 2.

Corrosion resistance—Although columbium has good corrosion resistance, it is not as resistant as tantalum. At ordinary temperatures columbium is resistant to most organic and mineral acids, but it is less resistant to alkalies. Resistance to mineral acids decreases with rise in temperature. Hot concentrated hydrochloric and sulfuric acids attack the metal to some extent, sulfuric acid also causing embrittlement.

Oxidation resistance—A major problem with reactive metals is the rate of oxidation at elevated temperatures. Gulbranson and Andrew have compared the oxidation resistance of several metals at 660 F and determined that the rate increased in the following order: titanium, zirconium, tantalum and columbium. Slight oxidation was noted as low as 400 F. Inouye has determined that the oxidation rate of columbium is linear. His data are given in Fig. 2.

Fansteel Metallurgical Corp. has reported that the oxide formed on columbium is adherent but dissolves in the metal when heated in a vacuum between red heat and 2200 F. However, Battelle investigators have been able to hot work columbium at 1800 F and obtain ductile material, indicating that the oxide does not dissolve appreciably at this temperature. Confirming these results, Murex Ltd. has been able to hot work columbium from ⅜-in. rod down to 0.076-in. wire without cracking, even though reheating 18 times to 1800 F was required to complete the operation. The wire was ductile.

TABLE 1—TYPICAL COMPOSITIONS OF COLUMBIUM, %

	Powder	Sheet
Carbon	0.25	<0.01
Oxygen	0.50	<0.01
Nitrogen	0.07	0.01
Tantalum	0.20	0.20
Silicon	0.08	<0.01
Iron	0.05	0.05
Titanium	0.02	0.02

Possibly of greater significance is a Fansteel investigation using samples 3.5 in. long, 1 in. wide, 0.281 in. thick at the top, and tapering to a radius of 0.025 in. at the bottom. After 7 hr at 2200 F, 35% of the columbium was oxidized but the remaining metal was ductile. Molybdenum tested under the same conditions oxidized and vaporized within 2 min. These results are very encouraging.

It is probable that the oxidation resistance of columbium can be improved by alloying, and McIntosh considers that improvement in oxidation resistance by alloying will not necessarily result in reduction of mechanical properties. He states that alloys with zirconium are promising.

Mechnical properties — Since columbium is promising for elevated temperatures service, the properties at such temperatures are important. Table 3 shows short time elevated temperature properties up to 1000 F. The metal retains most of its strength up to this temperature, though it loses about half of its ductility. Creep properties up to 1200 F are given in Table 4. Rupture tests at 1800 and 2000 F show that columbium is equal to and possibly superior to molybdenum at these temperatures.

The properties of a number of binary alloys containing up to 10% of the second element are given in Table 5. Although promising, these data permit no definite conclusions.

Fabrication

Ductile sintered bars (about 5/8 in. thick) of columbium can be cold rolled to 0.02-in. sheet (95% reduction) without intermediate annealing. Columbium can be

High temperature properties of columbium

TABLE 2—EFFECT OF TEMPERATURE ON PHYSICAL PROPERTIES

Temperature, F	Thermal Conductivity Btu/sq ft/ft/hr/°F	Electrical Resistivity, microhm-cm	Coef of Ther Exp per °F	
			Avg[a]	Instant.[b]
32	30.25	15.22	—	—
212	31.46	19.18	—	—
392	32.67	23.13	—	—
572	33.88	27.09	4.06 x 10	4.10 x 10^{-6}
752	35.09	31.04	4.10 x 10^{-6}	4.19 x 10^{-6}
932	36.54	35.00	4.15 x 10^{-6}	4.23 x 10^{-6}
1112	37.75	38.96	4.20 x 10^{-6}	4.37 x 10^{-6}
1292	—	—	4.24 x 10^{-6}	4.46 x 10^{-6}
1472	—	—	4.29 x 10^{-6}	4.55 x 10^{-6}
1652	—	—	4.33 x 10^{-6}	4.65 x 10^{-6}
1832	—	—	4.38 x 10^{-6}	4.73 x 10^{-6}

[a] Mean value between 65 F and temperature indicated.
[b] Instantaneous value at temperature indicated.
Source: *Tottle*

TABLE 3—EFFECT OF TEMPERATURE ON MECHANICAL PROPERTIES

Temperature, F	Proportional Limit, 1000 psi	Tensile Strength, 1000 psi	Elongation (in $4\sqrt{\text{area}}$), %	Modulus of Elasticity, psi
68	24.2	39.4	49	12.4 x 10^6
392	14.6	33.6	48	10.9 x 10^6
572	14.1	34.7	38	8.0 x 10^6
752	14.6	33.2	28	7.5 x 10^6
932	15.2	35.6	35	6.4 x 10^6
1022	10.5	32.3	24	4.7 x 10^6

Source: *Tottle*

TABLE 4—CREEP PROPERTIES

Material and Form	Temp, F	Stress, 1000 psi	Time for Specified % of Creep Strain, hr						Duration of Test, hr	Total Creep Strain, %
			0.05	0.01	0.2	0.3	0.5	1.0		
Columbium										
Swaged Bar	1112	8.96	50	160	860	2130	—	—	5519	0.306
Pressed and Annealed Slab[a]	1112	11.2	5	15	35	—	165	980	1359	1.08
As-Rolled	932	22.4	—	10	18	35	400	[b]	—	—
	1112	13.46	40	130	345	1160	—	—	—	—
Swaged Bar	1292	2.24	40	290	1560	—	—	—	2314	0.22
		4.48	80	205	550	—	—	—	5008	0.36
		6.72	120	220	540	1115	—	—	3335	0.40
Columbium—6¼% Molybdenum										
As-Rolled Rod	1112	8.96	5	20	—	—	—	—	600	0.22
As-Rolled Strip	1112	8.96	4	45	—	—	—	—	550	0.27
	—	13.46	1	2	6	14	50	—	500	0.56

[a] Minimum creep rate: 2.3 x 10^{-6} in./in./hr.
[b] Time required for creep strain of 0.6%: 1295 hr.
Source: *Tottle*

drawn, stamped or formed into complicated shapes by cold working. Machining can be performed with ordinary tools, but the metal's tendency to gall makes it preferable to use carbon tetrachloride as a coolant.

Columbium can be welded electrically by the spot, seam or butt methods. Arc welding requires special equipment, and the metal cannot be oxyacetylene welded.

TABLE 5—PROPERTIES OF COLUMBIUM ALLOYS[a]

Alloying Element, %	Proportional Limit, 1000 psi	Tensile Strength, 1000 psi	Elongation, %	Vickers Hardness	Electrical Resistivity, microhm-cm
Molybdenum					
5	48.6-54.4	58.3-67.2	8-17	131-150	17-18.1
6.25	—	84.2	15	150	—
7.5	69.2	90.0	13	159	—
10	53.2	69.4	8.5	167	17.6
Platinum (1)	31.5	43.5	13	94	—
Tantalum (10)	44.1-46.6	59.9-64.3	11-20	74-111	—
Titanium					
2	31.6	40.3	15	100	18.9
5	48.6	55.3	15	147	—
Tungsten					
5	29.8	44.6	8.9	111	—
7.5	56.9	75.5	10	113	—
10	57.8	66.5	9.9	191	21.1
Vanadium (2)	42.3	55.8	11	123	—
Zirconium					
1	24.0	42.1	18	75	15.8
2	31.6	44.8	12	94	17.5

[a]Properties of columbium used in preparation of these alloys: proportional limit, 32,200 psi; tensile strength, 41,100 psi; elongation, 29%; Vickers hardness 87; electrical resistivity 16.2 microhm-cm.
Source: *Tottle*

Applications

With the exception of density, the properties of columbium are very similar to those of tantalum. It may appear rather strange that though both metals have been in production for a long time, the development of tantalum has proceeded while that of columbium has remained stagnant. Despite its high cost, tantalum is used in electrical, electronic and chemical process equipment, not to mention surgical applications. If columbium, with half the density of tantalum, could be employed in these applications, and if its price were the same as that of tantalum, there would be considerable economic advantage in using columbium instead of tantalum. Because of its greater resistance to mineral acids, tantalum is preferred to columbium for chemical process equipment. Until

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Properties of Columbium Depend

The production of columbium is complicated by the fact that it is usually associated in nature with tantalum, and separation is rather difficult. Fortunately a new method (liquid-liquid extraction) has been developed that greatly simplifies the separation of tantalum and columbium and makes it possible to use ores previously considered uneconomical to process. In one of the variations a hydrofluoric-hydrochloric acid solution of the metal is extracted by aliphatic or aromatic ketones. The tantalum is more readily extracted than the columbium, which is left in the acid phase. Using methyl isobutyl ketone for extraction, high recoveries of high purity metallic oxides are produced.

Reduction from oxide

Production of metal from the oxide is difficult and expensive. A number of methods have been suggested, but apparently reduction of columbium oxide with columbium carbide in a vacuum is the only one used at present on a commercial scale. This method requires use of high temperatures and high vacuum to reduce residual oxide and carbon contents to satisfactory values. In the future it may be possible to reduce columbium pentachloride by magnesium or sodium. This method has been used to make tantalum and is used commercially in the production of titanium.

Metallic columbium is obtained in powder form (if chloride reduction by sodium or magnesium were used, sponge would probably result) and contains some oxygen, carbon, nitrogen and hydrogen in addition to small quantities of metallic impurities. A typical powder analysis is shown in Table 1. Consolidation by sintering or melting converts the powder to usable form. Sintering is generally employed because it combines consolidation with purification.

Powder metallurgy

Consolidation of columbium by induction or direct resistance heating in a vacuum has been described by O'Driscoll and Miller and by Williams. Best results are obtained if the columbium powder is first heated in vacuum at 2000 F to remove hydrogen and then blended with coarse powder produced by crushing and degassing columbium scrap that has been embrittled by hydriding. Bars are formed by pressing this blend at 30 tons per sq in.

In this process oxygen can be removed by volatilization as a lower columbium oxide at 3800 to 4200 F or by the interaction of oxygen and carbon at 3100 to 3450 F to form carbon monoxide. If sufficient oxygen is present, silicon is removed also. The second method (interaction of oxygen and carbon) is preferred because purification is conducted at a temperature below that required for evolution of the oxide; consequently there is little metal loss, there is less possibility of the bar bursting because of prior densification, and there is less chance of the bar distorting as a result of softening caused by lowering of the melting point by the contained oxide.

ecently, however, the columbium netal available has not been of he same degree of purity as the antalum, columbium containing some carbon which might be significant in its corrosion behavior.

Columbium has two potential applications where it would be preferred to tantalum: nuclear reactors and jet engines.

In the first case, it would be preferred because of its lower neutron absorption cross section. McIntosh considers columbium suitable as a canning material for uranium because of its compatability, strength and other properties. The choice of columbium as the canning material in the experimental fast reactor at Dounreay shows how highly it is regarded as a nuclear material by the U. K. Atomic Energy Authority. Columbium can also be used as an alloying element to stabilize the protective oxide film on uranium metal surfaces. Such an alloy, containing about 7% columbium, is said to be satisfactory, even in oxygen-free water, at temperatures as high as 660 F.

For high temperature applications such as jet engines columbium is favored over tantalum because of its lower density and easier fabrication.

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on How It's Made

In practice, after evacuating the furnace to a pressure below 10^{-4} mm Hg, the temperature is increased to the range 3100 to 3450 F in 40 min, held for about 3 hr until most of the carbon and silicon monoxides are removed, and then raised gradually over 6 hr to a temperature of 4200 F. The bar is maintained at the top temperature for 6 hr to remove the impurities and obtain sufficient densification to yield a ductile product. The sintered bar shrinks linearly about 15% and has an apparent hardness of Vickers DPN 75 at 93% theoretical density. A second sintering at 4200 F increases the density to 98% of theoretical with a Vickers hardness of 85. Degree of purification is indicated by the analysis given in Table 1 for sheet. A modification of this method has also been described by Williams.

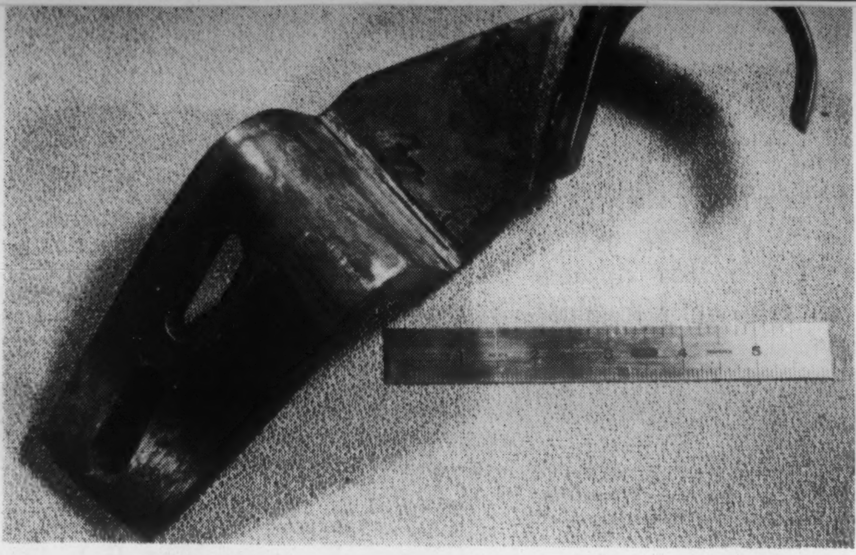
Alternately a two-stage sintering process can be used. In this process the degassing period at 3100 to 3450 F is cut short and the partially sintered brittle bar is crushed, recompacted and resintered. This method is advantageous because the primary heating can be performed rapidly and final degassing is done on a porous bar instead of one that has been partially densified.

Arc melting

It seems that the logical method to convert columbium powder to billet would be to melt it, using the method developed for the reactive metals titanium and zirconium, i. e., arc melting with a consumable electrode. However, arc melting columbium powder presents problems that are not encountered with titanium and zirconium which, except for a small amount of hydrogen, magnesium (or sodium) and magnesium (or sodium) chloride, are in a high state of purity. Columbium powder as produced contains, in addition to hydrogen and nitrogen, combined oxygen and carbon that are only removed by heating for a considerable period in a vacuum.

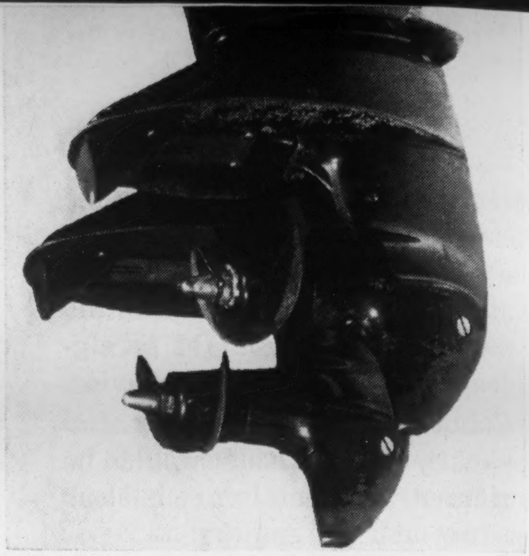
In discussing the possibility of arc melting columbium to form ductile metal, Williams points out that the short time between melting and solidification prohibits the use of virgin powder in the electrode, and success can only be obtained by using columbium metal purified by pretreatment. Obviously the impurities can be removed by presintering, but unless this can be performed fairly cheaply it would tend to make arc melting uneconomical. It would be difficult to produce completely purified metal without a long, expensive treatment and, unless some degree of purification is possible during arc melting, metal produced by the sintering process will be inherently softer than that produced by arc melting.

The advantages offered by fair sized ingots of metal compared with sintered bars of only a few pounds are so attractive that every effort will be made to overcome the present difficulties of arc melting. The practical and economical advantages of handling larger billets of metal may well outweigh the disadvantage of slightly greater hardness.



Polymer Corp.

***Steel loading hook** used on precision grinder is coated with nylon to prevent galling or scratching of parts.*



***Outboard motor** with polyamide-epoxy coating was photographed after rugged service testing to illustrate durability of finish.*

Polyamide Protective Coatings

They can be used to protect metals or plastics from abrasion, heat, water, grease, acids and alkalies.

by Don E. Floyd,

General Mills, Inc.

■ Because of their unique properties, polyamide resin films are used in a variety of applications to: 1) protect surfaces from abrasion, scratching and other frictional forces; 2) protect surfaces from weathering and from chemicals and solvents, 3) inhibit corrosion and 4) enhance product appearance.

Most polyamide resin films are either supported on a surface or encased around an object such as wire. Unsupported polyamide films are produced, but their applications have not yet assumed the significance of other unsupported films such as cellophane, Mylar and polyethylene.

Rilsan

Rilsan is the trade name for polyamide-11, which is prepared by the polymerization of 11-amino undecanoic acid. Unsupported Rilsan sheets or films made by extrusion of the molten polymer, are primarily used for packaging. These films are available in clear or colored form and can be heat sealed. Thickness of the films ranges from 2 to 8 mils.

The film can be cut into tape for wrapping electric cable, and can be treated with adhesives to provide a tough, high strength adhesive tape for general use. Sheets or films can also be used as laminate facings to protect the the base material from chemicals, solvents and corrosion. The films are laminated to paper, metal, foil, fabrics and other plastics films to increase the utility of packaging, insulation and other tape materials.

Rilsan can be flame sprayed on most metals and paper. A flame gun is used to project the powder by air pressure through an oxy-acetylene flame. Since the material is tasteless and nontoxic it can be used for lining food containers. Sprayed coatings are particularly valuable in protecting electrical parts, such as switch boxes and casings, that are exposed to corrosion in mines, on ships and in tropical atmospheres.

To prevent blistering and lifting of the film, surfaces must be dry, clean and nonporous before application. The radius of interior angles should not be less than 0.2 in. Best results are obtained by preheating metal surfaces to a minimum of 212 F and paper surfaces to about 140 F. Preferred coating thicknesses range from 5 to 15 mils.

Correctly applied coatings possess a low coefficient of friction and excellent adhesion, and they are very resistant to shock and vibration. Moisture pickup of the coating in service is less than 1%. Thermal conductivity is high (about 0.58 Btu/sq ft/hr/°F/ft) and the coatings have a useful

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This article is based in part on material that will appear in Mr. Floyd's forthcoming book entitled "Polyamides." The book is part of a series on the application of chemical materials being issued by Reinhold Publishing Corp.

Runabout boat *of glass fiber-reinforced plastics has polyamide-epoxy coating to increase resistance to water and abrasion.*

temperature range of −76 to +284 F.

Nylon

Nylon coatings on metal surfaces make is possible to combine the desirable frictional and wear characteristics of nylon with the greater strength, dimensional stability and lower cost of metals (see "Nylon Coated Parts for Wear Resistance," M&M, June '55, p 92). Adherent coatings ranging in thickness from 0.002 to 0.030 in. have been applied to many types of steel, including stainless, and aluminum. Ceramics have also been coated successfully.

Nylon coatings (see Table 1 for properties) of 0.010 to 0.020 in. are preferred for most purposes; however, in some cases thinner coatings down to 0.002 to 0.003 in. are desirable. Thin coatings have better wear resistance, presumably because of their better heat dissipation.

Nylon coatings can be applied in several ways, including flame spraying and a newly developed whirling process. In this process, nylon powder is held in suspension in a closed vessel by means of circulating air. The article to be coated is heated above the melting point of the resin and plunged into the vessel and held there until it is coated to the desired thickness.

Nylon dissolved in cresylic acid is used for coating magnet wire intended for Class A applications. Mechanical and electrical properties of the coating are good; however, the material does have a tendency to absorb moisture. Also, it is thermoplastic and melts at high temperatures.

Unsupported nylon film is available, but to date there do not appear to be too many applications for the material in this form.

Vegetable oil polyamides

Vegetable oil polyamide resins are soluble in alcohols and in alcohol-hydrocarbon mixtures. They are used alone or with plasticizers or other modifiers as surface coatings on a variety of metallic and nonmetallic surfaces including: steel, aluminum, copper, cellophane, Mylar, polyethylene, paper, paperboard and wood.

The coatings are noted for their heat seal properties and their resistance to grease and water. Soluble polyamides are frequently applied over printed surfaces as glossy overprint varnishes for protection against abrasion, oil and water, and to improve appearance.

TABLE 1—PROPERTIES OF NYLON COATINGS

Type ➤	Polyamide-11	Nylon-6, 6
Elongation (73 F), %	120	90
Tensile Strength (73 F), psi	8500	10,500
Modulus of Elasticity (73 F), psi	178,000	400,000
Rockwell Hardness	R 100.5	R 118
Specific Gravity	1.04	1.14
Moisture Pickup, %	0.4	1.5
Ther Cond, Btu/sq ft/hr/°F/in.	1.5	1.7
Dielectric Strength (short time), v/mil	430	385
Dielectric Constant (10^3 cycles)	3.5	4.0
Effect of:		
Weak Acids	None	None
Strong Acids	Attacked	Attacked
Strong Alkalis	None	None
Alcohols	None	None
Esters	None	None
Hydrocarbons	None	None

Straight polyamide coatings can be applied by hot melt methods such as dipping and roller or knife coatings, or can be applied from solution by spraying, brushing, dipping and roller or knife coating. The coatings are used in thicknesses as low as 0.1 mil on paper and as high as 5 mils on metallic surfaces. A thickness of ¾ to 1 mil is generally sufficient for most surfaces.

Thermosetting resin alloys

Thermosetting resin alloys are made from a type of polyamide that contains free amino groups and is very reactive with epoxy resins. Combination of the amino-containing polyamide resin with epoxy resins (Tables 2 and 3) and with phenolic resins (Table 4) produces coatings that are quite resistant to chemicals, solvents, heat and water. These coatings also provide excellent protection against corrosion for iron and steel surfaces.

Polyamide — epoxy coatings— Usually the polyamide and epoxy resins are prepared separately in the form of concentrates, and then combined and reduced with thinners to the proper application viscosity. The solvents used most often for the polyamide part of the system are mixtures of alcohols and hydrocarbons. The epoxy resin portion is dissolved in a mixture of ketone and aromatic hydrocarbons such as methyl isobutyl ketone and xylene.

Both resins are excellent wetting media and are well adapted to pigment grinding. All of the common types of pigments can be handled satisfactorily including: carbon blacks, titanium dioxide, chrome yellow, phthalocyananine greens and blues, toluidine red, red lead and zinc chromate. Pigmented coatings possess a high gloss and an unusual degree of hardness and flexibility combined with resistance to solvents and chemicals.

Polyamide-epoxy coatings can be applied by most common coating methods such as spraying, dipping or brushing. During dipping, care must be taken not to exceed the pot life of the material, especially if a continuous system of introducing fresh material is employed. In general, thicknesses of the polyamide-epoxy coatings are about the same as for the straight polyamide coatings described above. Approximate cost of the coatings ranges from $5.50 to $6.50 per 1000 sq ft per dry mil.

Both artificial and natural weathering tests show that polyamide-epoxy resin coatings have excellent durability. The coatings exhibit little tendency to check or crack and have excellent color retention. It is only after long time periods, that the coatings will fail by gradual erosion or chalking. Actually, the rate of chalking is not much greater than for conventional coatings such as the alkyds; in addition, durability is better and beneath the chalked surface there exists a glossy, intact coating.

Like other polyamide coatings, polyamide-epoxy coatings have excellent resistance to the passage of moisture vapor. A typical polyamide-epoxy coating, for example, has a specific permeability of 0.28 as compared to 3.0[6] for linseed

TABLE 2—PROPERTIES OF AIR DRIED POLYAMIDE-EPOXY RESIN COATINGS

Property ↓ / Type ➤	Epon 1001[a]: Ethylene Diamine (100:6)	Versamid 100[b]: Epon 1001 (50:50)	Versamid 115[c]: Epon 1001 (50:50)	Versamid 115: Epon 1001 (35:65)
Time to Dry Tack Free, min	130	65	80	80
Initial Gloss of White Enamel[d]	90	102	102	103
Gloss After Weatherometer Exposure				
300 hr	65	93	81	73
500 hr	5	36	30	12
Initial Light Reflection (Hunter green filter), %[e]	77.0	77.4	76.4	—
Initial Yellowness[f]	1.4	3.6	2.1	—
Yellowness After 300 Hr in Weatherometer	11.8	9.4	10.2	—
Chalking After 300 Hr in Weatherometer	Heavy	Medium	Medium	Medium
Resistance to:				
Boiling Water After 7 Hr	OK	OK	OK	OK
20% Sodium Hydroxide (1 day exp)	Hard	Hard	Hard	Hard
50% Sulfuric Acid (1 day exp)	Hard	Hard	Soft	Soft
Sward Hardness				
1 Day	28	24	26	33
1 Week	42	48	50	59
1 Month	47	50	50	—
Impact Resistance, in-lb[g]				
1 Day	30+	2	30+	30+
1 Week	30+	30+	30+	30+

[a] Epoxy resin with melting point of 147-169 F and epoxide equivalent (grams of resin containing 1 gm equivalent of epoxide) of 425-550.

[b] Vegetable oil polyamide resin with molecular weight of 6000-9000 and softening point near 104 F.

[c] Vegetable oil polyamide resin with amine number of 210-220.

[d] Gloss value of 95 indicates that surface has 95/1000 of the gloss of a perfect mirror.

[e] % of light reflected compared with magnesium oxide standard.

[f] Yellowness defined as 100 x (A-B) ÷G; where A = light reflectance with standard amber filter. B = reflectance with blue filter, and G = reflectance with green filter.

[g] Tested on 31-gage, hot dip tin coated steel panels.

TABLE 3—PROPERTIES OF BAKED POLYAMIDE-EPOXY RESIN COATINGS[a]

Property ↓ / Type ➤	Epon 1001[f]: 6% Diethylene-triamine	Epon 1001: Versamid 100[g]			Epon 1007[h]: Versamid 100			Epon 864[i]: Versamid100	
		40:60	50:50	60:40	40:60	50:50	60:40	50:50	60:40
MECHANICAL PROPERTIES									
Hardness, % of plate glass	68	34	56	62	44	57	57	41	49
Min Bend Radius, in.	⅛	⅛	⅛	⅛	⅛	⅛	⅛	⅛	⅛
Impact Resistance, in.-lb[b]	50-120	172	172	172	172	172	172	172	172
Abrasion Resistance, gm loss[c]	0.002	0.0073	0.0054	0.0035	0.0115	0.0074	0.0011	0.0019	0.0121
CHEMICAL RESISTANCE									
Alkalies and Acids									
20% Sodium Hydroxide[d]	OK	OK	OK	OK	OK	OK	OK	OK	OK
20% Acetic Acid	OK	OK	OK	OK	OK	OK	OK	OK	OK
50% Sulfuric Acid	OK	OK	OK	OK	OK	OK	OK	OK	OK
Solvelnts									
Touene[e]	OK	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft
50% Ethyl Alcohol[e]	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft
High Test Gasoline[e]	OK	OK	OK	OK	OK	OK	OK	OK	OK
Boiling Water (30 min)	OK (slight blush)	Soft (rec)[j]	OK	OK	OK	OK	OK	Soft (rec)[j]	Soft (rec)[j]

[a] Cured at 300 F for 20 min.

[b] Measured by dropping 4-lb weight with ½-in. radius on reverse side of coated steel panels.

[c] 500 cycles, 1 kg load, No. 10 wheel.

[d] Observed after 3 days immersion at 170 and 212 F.

[e] Films held for 7 days at room temperature, then immersed 1 day in test liquid.

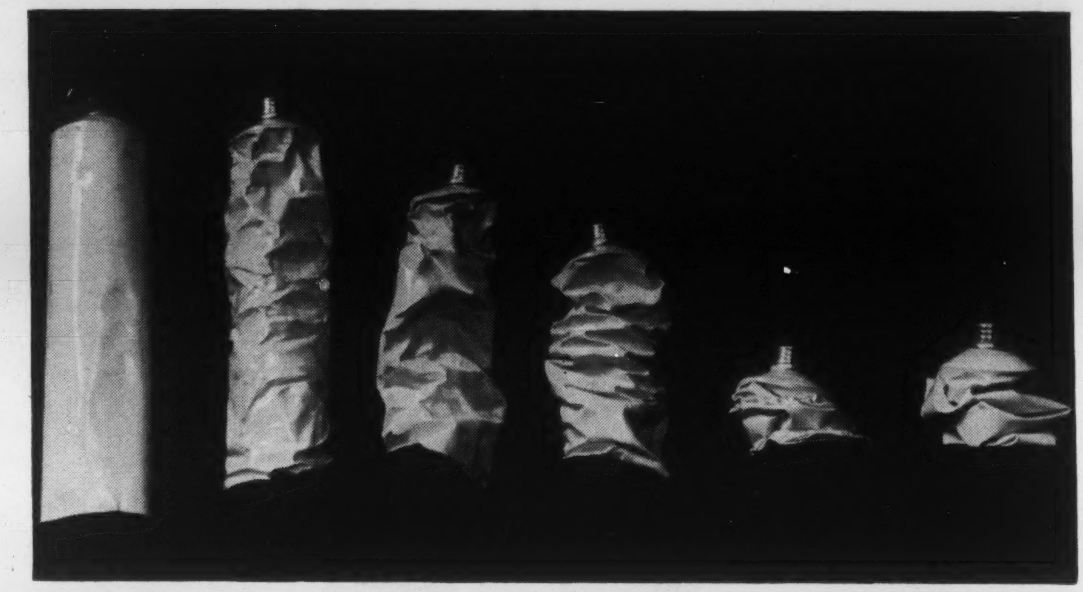
[f] Epoxy resin with melting point at 147-169 F and epoxide equivalent (grams of resin containing 1 gm equivalent of epoxide) of 425-550.

[g] Vegetable oil polyamide resin with a molecular weight of 6000-9000 and softening point near 104 F.

[h] Epoxy resin with melting point of 257-275 F and epoxide equivalent of 1900-2450.

[i] Epoxy resin with melting point of 104-113 F and epoxide equivalent of 300-375.

[j] Recovered within 1 hr.



Flexibility *of polyamide-epoxy coating is demonstrated by collapsible tubes in extended and crushed conditions.*

oil and 1.0[6] for clear varnish. Since the coatings are corrosion inhibitors and excellent wetting agents, they may be applied over wet surfaces by brushing. Apparently the brushing action causes water on the surface to become emulsified in the coating. When the coating dries the water is carried out along with the solvent.

Polyamide-epoxy coatings are widely used on dairy equipment, pipelines, oil well riggings, freight car interiors, water softeners, and industrial and chemical laboratory equipment, and as general maintenance finishes. The coatings are quite adherent and, with few exceptions, can be applied to most metal, wood, rubber, plastics and masonry surfaces.

Polyamide-phenolic coatings—Baked coatings blended of polyamide resins and heat reactive phenolic resins possess the extremely good chemical and solvent resistance of the phenolic resins combined with the flexibility, impact resistance and resistance to alkalies of the polyamide resins. The reaction of the two resins is between amino groups of the polyamide and methylol groups of the phenolic resins. This reaction forms a new carbon-to-nitrogen bond which links the two resins and releases a by-product molecule of water; by contrast, in the polyamide-epoxy resin reaction no volatile by-product is formed.

Blends of polyamide resins and heat reactive phenolic resins in solution may be stored for several months before any noticeable change in viscosity or coating properties occurs. For this reason the coatings can be used in applications for which the straight polyamide and polyamide-epoxy coatings are not suitable. However, polyamide-phenolic coatings require baking at temperatures of at least 300 F, whereas polyamide-epoxy coatings cure at temperatures as low as 50 F.

Polyamide-phenolic coatings are usually applied in thicknesses from 0.1 to 1.0 mil. Although other application methods are satisfactory, the coatings are generally applied by spraying or rolling.

Because of their desirable properties, polyamide-phenolic coatings are used to line tanks, drums, cans and pails. The coatings are not pigmented as frequently as polyamide-epoxy coatings; pigments are used primarily for corrosion protection rather than decoration.

TABLE 4—PROPERTIES OF POLYAMIDE-PHENOLIC RESIN COATINGS[a]

Type ➤ Property ▼	Versamid 100[b]: BR-17913[c] (60:40)	Versamid 125[d]: BR-17913 (50:50)	Versamid 115[e]: P-97[c] (45:55)	Versamid 115: BV-1112[c] (50:50)	Versamid 125: BV-9700[c] (55:45)	Versamid 115: BV-9700[c] (55:45)	Versamid 115: Varcum 5301[c] (45:55)	Straight Baking Phenolic Resin
MECHANICAL PROPERTIES								
Rocker Hardness	56	58	68	66	60	58	58	72
Impact Resistance, in.-lb	16-30	2-4	16-30	60+	4-8	30-60	16-30	<2
CHEMICAL RESISTANCE								
Acids and Alkalies (1 day exp)								
20% Sodium Hydroxide	H	H	H	H	H	H	H	Wr
37% Sulfuric Acid	H	H	H	H	H	H	H	H
Solvents (120 F for 48 hr)								
Acetone	S	H	S	S	H	SS	SS	H
Toluol	H	H	H	H	H	H	H	H
Ethanol	S	H	H	S	H	SS	H	H
Oleic Acid	H	H	H	H	H	H	H	H
Water	H	H	H	H	H	H	H	H
Boiling Water (2 hr)	—	—	H	H	H	H	H	—

[a] Baked films (15 min at 400 F) of about 0.4 mil on tin plate or glass. H = hard, SS = slightly soft, S = soft, VS = very soft. Wr = Wrinkled. Hardness is judged by fingernail scratch immediately on withdrawal of panel from liquid.

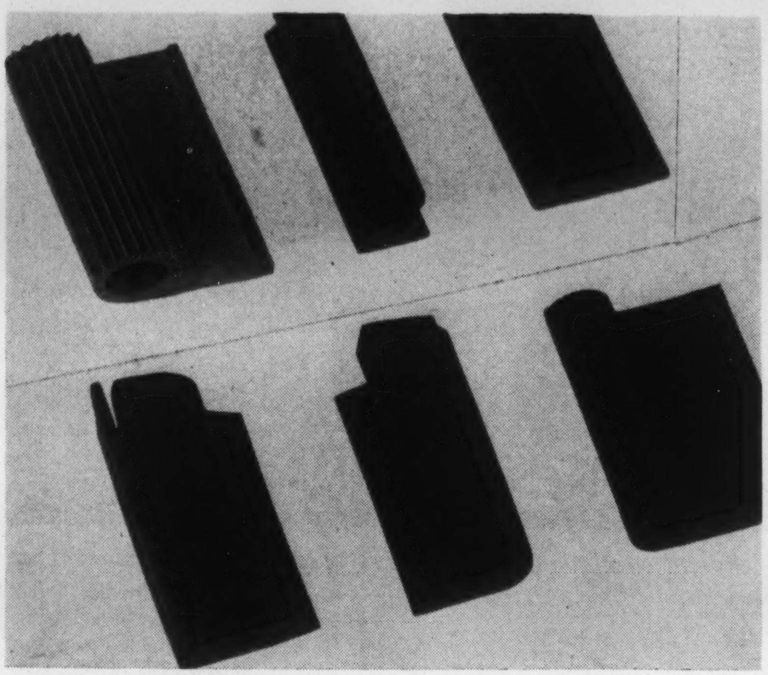
[b] Vegetable oil polyamide resin with molecular weight of 6000-9000 and softening point near 104 F.

[c] Heat reactive phenolic resin.

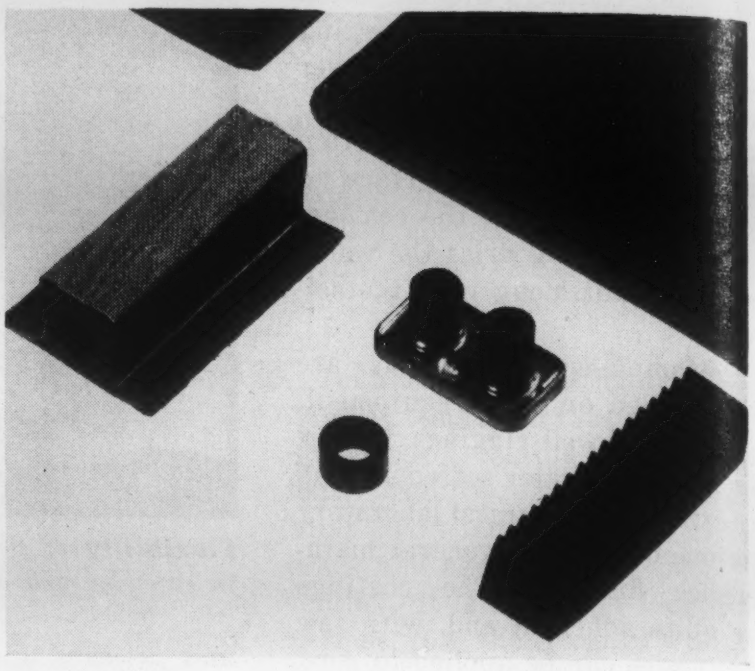
[d] Vegetable oil polyamide resin with amine number of 290-320.

[e] Vegetable oil polyamide resin with amine number of 210-220.

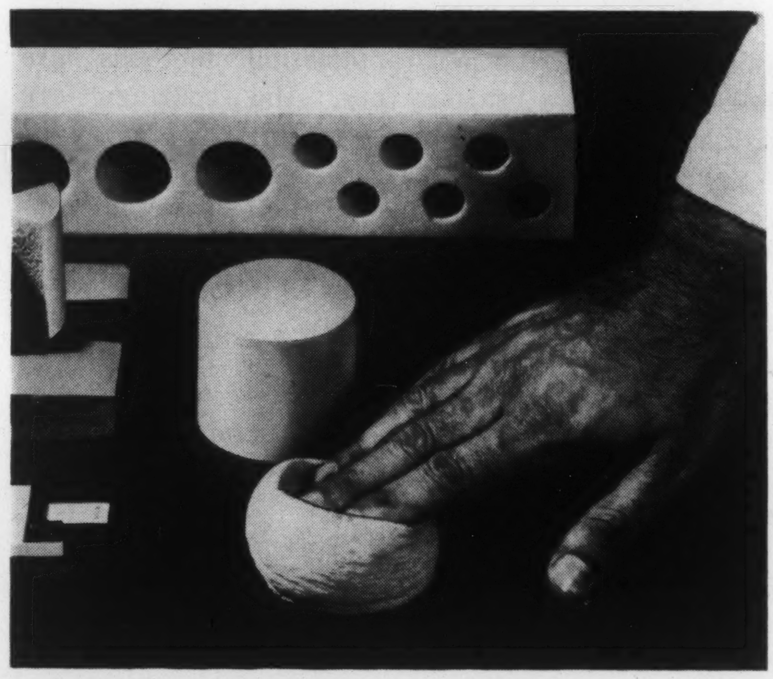
Silicone rubber parts can be specified as . . .



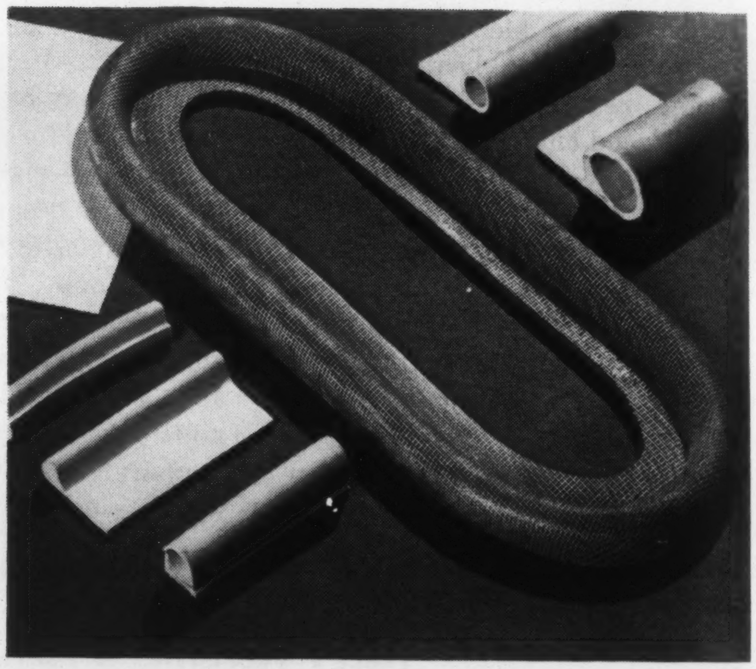
Extrusions



Moldings



Foams or sponge



Coated fabrics

Selecting Silicone Rubbers

PART 1—

Fundamentals and Commercial Types

by F. L. Kilbourne, Jr., A. S. Kidwell and T. S. Moroney,
Connecticut Hard Rubber Co.

■ Silicone rubber is one of the most stable rubbers known. It has extremely high resistance to heat, cold, ozone, oils and chemicals. Not every type of silicone rubber will show maximum resistance to all of these environments. However, selection of the proper stock and intelligent compounding by the materials supplier makes possible compromises that provide

A Two-Part Series

This is the first of two articles intended to aid the designer in his approach to silicone rubber—an engineering material that has become increasingly important and, as the number of modifications grows, increasingly complex. The second article next month will discuss significant properties in some detail.

optimum blends of properties.

In the last six years silicone rubber technology has become quite complex. In 1951 only two basic silicone rubber gums were available. Today there are 19. Each of these can be compounded with the proper catalysts, fillers and additives to meet specifications calling for a wide range of physical properties and design requirements. The purpose of this article is to provide the specifying engineer with an understanding of the properties obtainable in various types of silicone rubbers, and also with a basic understanding of the nature of the silicone rubber polymer.

Silicone rubber compounds can be conveniently grouped into six major types according to characteristic properties. These types are: 1) general purpose, 2) extreme low temperature, 3) extreme high temperature, 4) low compression set, 5) high tensile-high tear, and 6) fluid resistant. These various compounds are obtained by mixing various gum polymers (see "Silicone Rubbers: A Basic Discussion" on page 142) with other compounding ingredients. Accompanying tables show minimum values required by AMS specifications, as well as typical properties obtained with high grade silicone rubber compounds. The following sections outline general property limits obtainable with various grades.

General purpose

General purpose compounds are available in hardnesses of 40 to 90 Shore A durometer, tensile strengths of 700 to 900 psi and ultimate elongations of 100 to 300%. Their service temperature range extends from −65 to 500 F, they have good resistance to heat and oils, and they have good electrical properties.

These compounds are prepared from a relatively wide variety of gums and fillers, selected to provide a desired balance of properties over a wide hardness range. Standard methyl, low shrinkage methyl or vinyl-containing methyl gums can be used along with reinforcing, semireinforcing or extending fillers and a peroxide vulcanizing agent. The reinforcing silica fillers and special gums are somewhat higher in cost than the semireinforcing fillers and the standard methyl gum. Since the per pound cost of the filler is at most 1/20 that of the gum, the lowest cost compounds are those containing the greatest loading of semireinforcing or extending fillers.

Extreme low temperature

Extreme low temperature compounds have brittle points near

AMS SPECIFICATIONS FOR SILICONE RUBBERS

Property / Type	General Purpose					Electrical[b]	High Tensile - High Tear[c]	
	3301B	3302B	3303C	3304B	3305C	3356	3345	3346
Durometer Hardness (Shore A)	40 ±5	50 ±5	60 +5	70 ±5	80 ±5	60 ±5	50 ±5	60 ±5
Tensile Strength (min), psi	500	500	400	500	500	600	1000	1000
Elongation (min), %	250	200	100	60	60	175	500	500
Tear Strength (min), lb/in.	55	35	35	25	25	50	150	150
Oil Resistance (after 70 hr in ASTM #1 oil at 350 F)								
Durometer Change	−15 to + 5	−15 to + 5	−10 to + 5	−10 to + 5	−10 to + 5	−15 to + 5	−10 to + 5	−10 to + 5
Reduction in Ten Str (max), %	50	40	20	20	10	35	40	25
Reduction in Elong (max), %	50	20	20	20	10	20	50	35
Volume Change (max), %	0 to +15	0 to +15	0 to +10	0 to +10	0 to +10	0 to +15	0 to +15	0 to +15
Decomposition	None	None	None	None	None	None	None	None
Surface Tackiness	None	None	None	None	None	None	None	None
Dry Heat Resistance (24 hr at 450 F)								
Durometer Change	0 to +10	0 to +10	0 to +10	0 to +10	0 to +10	0 to +10	0 to +20	0 to +20
Reduction in Ten Str (max), %	15	10	10	10	10	−15	40	40
Reduction in Elong (max), %	25	25	25	25	25	−20	50	50
Surface Hardening	None	None	None	None	None	None	None	None
Bend Flat	No cracking or checking	No cracking or checking	No cracking or checking	No cracking or checking	No cracking or checking	No cracking or checking	No cracking	No cracking
Compression Set (compressed 22 hr at 350 F)								
Percent Orig Deflection (max)	72	72	60	30	36	40	73	70
Percent Orig Thickness (max)	29	22	18	8	9	12	—	—
Low Temperature Brittleness[a]								
5 hr at −70 F	—	—	Pass	Pass	Pass	f		d
5 hr at −85 F	Pass	Pass	—	—	—	—	d	e

[a] ASTM D736-46T.

[b] Dielectric strength must be 350 v per mil min, and after water immersion for 48 hr at 77 F, hardness must not increase more than 5 durometer and dielectric strength must not decrease more than 15%.

[c] Oil resistance values on these grades are specified after conditioning for 70 hr at 300 F; dry heat resistance after 70 hr at 400 F; compression set after 70 hr at 300 F.

[d] Pass at —100 F, ASTM D797-46 (Young's Modulus).

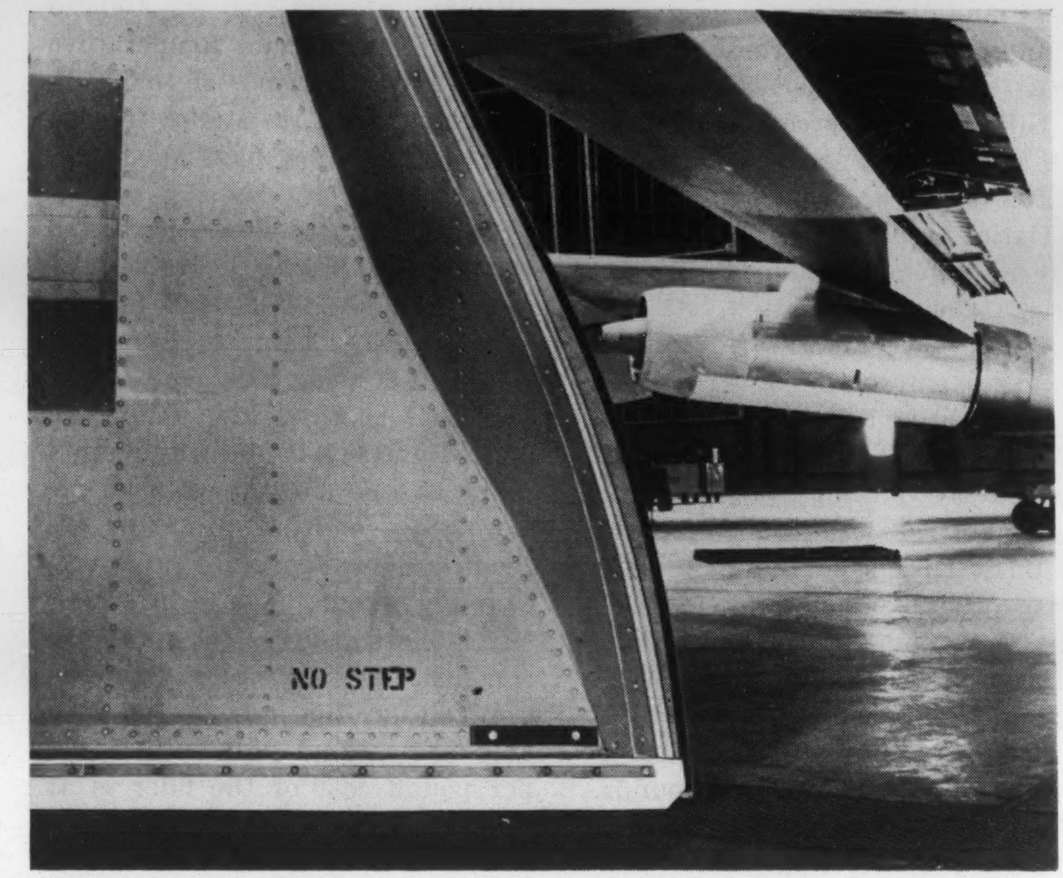
[e] Pass at —105 F, ASTM D746-54T.

[f] Pass at —65 F.

—180 F and are quite flexible at —120 to —130 F; in comparison, brittle points for general purpose compounds are about -80 to -90 F. General physical properties of extreme low temperature compounds are about the same as those of general purpose stocks, with some reduction in oil resistance. The low temperature flexibility of extreme low temperature compounds is due to the incorporation of a relatively small number of phenyl groups—about 5 to 10%—on the polymer chain.

Extreme high temperature

Extreme high temperature compounds are considered serviceable at temperatures up to 600 F, and will withstand brief exposures at 700 F; in comparison, general purpose compounds are limited to about 500 F for continuous service and 600 F for intermittent service. The improved high temperature stability of these com-



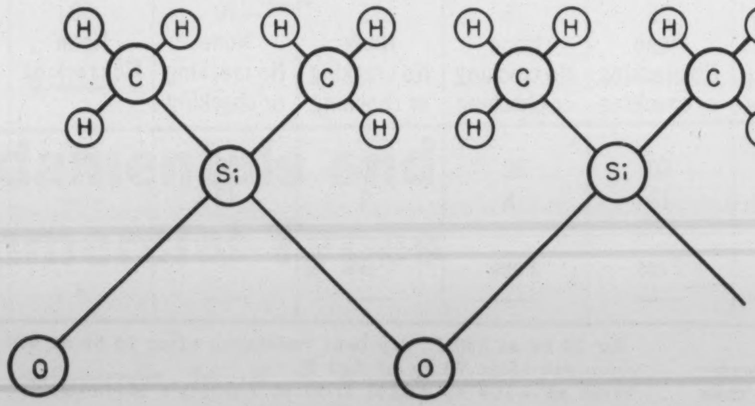
Teflon film *laminated to silicone rubber is used as a bomb bay door seal on the Boeing B-47. Teflon provides a low-friction surface, and it provides abrasion resistance and stability over wider temperature ranges.*

Silicone Rubbers—

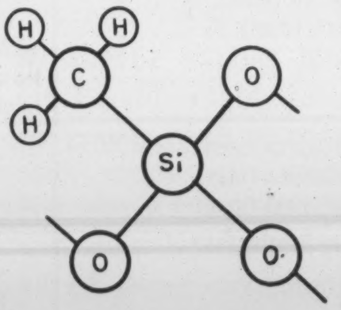
What they are

For a polymer to be a rubber or elastomer, it must consist of long, chain-like molecules which are in a coiled position. When the rubber is stretched the molecules uncoil without breaking; when the rubber is released they recoil again. Some long chain molecules, such as those in fibers or rigid plastics, are not in a coiled position; they are strong but not elastic. Rigid plastics, as we generally use them, are in the frozen state, and fibers are in a stretched and frozen state. Rubbers are unfrozen, unstretched and unoriented. Thus they are capable of sustaining large deformations without rupture, and will return to their original dimensions.

Silicone rubbers, which are polysiloxanes, are high polymers in which the monomer groups which repeat themselves and are joined together to form the long chain molecules consist basically of Si-O, i.e., a silicon atom and an oxygen atom held together by valence forces (the chemical bonds between various atoms). Each silicon atom also has further capacity to bond to other atoms. Additional valences of the silicon atom hold onto side chains such as methyl groups (-CH$_3$). Such polysiloxanes are fluid or rubber-like materials because they can grow in only two directions (see accompanying sketch). Polysiloxanes that can grow in more than two directions—because they are attached to additional oxygen atoms with free valences—form other types of materials. Silicone resins, for example, have three oxygen atoms attached to the silicon atom, and thus can grow in three directions. Sand or quartz is a



A rubber *(dimethyl polysiloxane)*



A resin *(methyl polysiloxane)*

pounds results from the use of either standard or low shrinkage methyl gum with a precipitated silica filler and a carefully controlled amount of curing catalyst.

Low compression set

Low compression set compounds provide typical values of 12 to 20% compression set after 22 hr at 300 F. They also have improved resistance to petroleum oils and various hydraulic fluids, and are particularly suitable for use in o-rings and gaskets. Their general physical properties are about the same as those of general purpose compounds, but average elongation values are slightly lower.

Low compression set values can be obtained by either of two methods. The first is the use of a vinyl-containing methyl gum, and an alcohol-type peroxide. The second method makes use of a low shrinkage methyl gum and the standard peroxide catalyst with an additive, such as mercurous oxide, cadmium oxide or ditertiarybutyl quinone.

A special, newly developed compound in this latter group shows extremely low shrinkage after molding and curing. It consists of methyl-vinyl gum, dichlorobenzoyl peroxide catalyst, and a mixture of silica and diatomaceous earth. Its linear shrinkage is only 2%, compared to 5 to 6% for usual silicone rubber compounds. This compound is of particular interest in molding large volume, standard size items such as o-rings where, because of the low shrinkage, standard molds for other rubbers can be used.

PROPERTIES OF SOME TYPICAL SILICONE RUBBERS[a]

Type / Property	General Purpose				High-Tensile High Tear	Reversion Resistant	Fuel Resistant
Durometer Hardness (Shore A)	25 ±5	40 ±5	50 ±5	70 ±5	50 ±5	60 ±5	60 ±5
Tensile Strength, psi	700	700	750	600	1450	800	850
Elongation, %	450	300	300	75	750	175	225
Tear Strength, lb/in.	30	60	75	100	200	100	75
Compression Set (22 hr at 350 F), % orig deflection	30	36	40-50	20-25	50[b]	20[c]	30[d]
Max Service Temp, F							
intermittent	450	500	480	500	400	500	350
continuous	600	600	600	600	450	700	450
Low Temp Fexibility, F	−100	−85	−65	−65	−100	−85	−85

[a] Since a wide variety of property combinations can be specified, values given here should be considered only as those which could be expected of some high grade stocks. Oil resistance and dry heat resistance would exceed AMS specifications by a considerable margin. Values were obtained on 3/16-in. slab specimens.

[b] 22 hr at 300 F. [c] 20 hr at 350 F. [d] 70 hr at 212 F.

A Basic Discussion

polysiloxane with four oxygen atoms attached to each silicon atom.

How gums are modified

Side chains on the polysiloxane molecule account for many of the important properties of silicone rubbers, and modifications of these side chains impart various desirable properties to the rubber. Each gum shown in the accompanying list of proprietary gums has undergone some type of side chain modification to provide rubbers made from the gums with different physical properties. The effects of altering side chain arrangements can be shown by the following examples.

As suggested by the accompanying sketch of dimethyl polysiloxane, the methyl side chain groups occur with astonishing regularity along the basic Si-O chain. In fact, they occur with such regularity that when the material is cooled to about -65 F many segments of the chain slow up and nest themselves into the "hills and valleys" of adjacent chains and "lock arms." Thus certain areas of the rubber freeze to a semicrystalline state but are separated from each other by areas of unfrozen rubber. This temperature is the so-called first order transition point, comparable to a gelling point. In this condition the rubber is stiff like a rigid plastic. Upon cooling further—to the so-called second order transition point—all vibrational or rotational activity of the molecule stops and the rubber becomes brittle. Though the "brittle point" of most rubbers, as measured by a standard test, is usually close to the second order transition point, in silicone rubber it is actually closer to the first order transition point.

In order to modify a silicone rubber to lower its brittle point, a few percent of the methyl side chain groups can be replaced with phenyl groups $(-C_6H_5)$. Such groups are much bulkier than methyl and prevent the long chains from nesting together as easily. Such rubbers must be cooled to temperatures much below -100 F before the brittle point is reached.

The high temperature stability of silicone rubbers is dependent on the strength of primary valence bonds. The weakest valence bond in the polysiloxane molecule is the silicon-carbon bond; consequently the side chains of the molecule can be oxidized off the Si-O chain. The bond between silicon and an ethyl group starts to oxidize at 300 F, the bond between silicon and a methyl group starts to oxidize at 400 F, and the phenyl group is the most stable, oxidation starting at 500 F. The Si-O skeleton is not affected by oxidation of the side chains in air until much higher temperatures are reached. The phenyl group, too bulky to be used except sparingly in the siloxane rubber molecule, is responsible for heat stability of silicone resins.

Side chain construction also determines whether the rubber molecules attract each other strongly or simply lie side by side quietly—a factor that determines the degree to which rubber will swell in solvents.

How they're cured

Vulcanization is a process of introducing crosslinks at intervals between the long chain molecules. These links are primary valence bonds acting like knots be-

High tensile—high tear

High tensile-high tear strength compounds have been developed relatively recently (see M&M, Jan '55, p 142, and this issue, p 187). They provide tensile strengths ranging from 1100 to 1700 psi and elongations ranging from 500 to 700%. Tear strength ranges from 175 to 250 lb per in. thickness, compared to 10 to 80 lb per in. for other silicone rubbers. Such compounds do not have the resistance to high temperatures obtainable with standard silicone rubber compounds, but incorporation of an antioxidant boosts the continuous service limit to 400 F and the intermittent service limit to 500 F.

The high mechanical properties of this type of rubber can be produced by use of an alkoxy-coated silica filler and very high molecular weight gums. The gums can be either straight methyl or, when extreme low temperature flexibility is an added requirement, methyl-phenyl.

Fluid resistant

Compounds with good fluid resistance have long been in demand to complement the other desirable properties of silicone rubbers. Recently a fluoro-silicone rubber, which has excellent resistance to a wide range of fuels, lubricants and hydraulic fluids (see M&M, Nov '56, p 163), has been developed. Physical properties are about the same as those of the general purpose grades, though the service temperature range is not as broad. Low temperature properties are about the same as those of the straight methyl polymer, the brittle point occurring around −80 F. The upper service limit is around 500 F. The unusual fluid resistance of this rubber is apparently due to the substitution of a fluorine-containing group along the silicone polymer chain.

Commercially Available Gums

Dimethyl

GE SE76, 81465, SE30
DC 400, 401
UCC W95

Methylphenyl

GE SE51, SE52
DC 440, 6531

Methyl trifluoro propyl

DC LS53

Methylvinyl

GE SE33, SE31
DC 410, 430
UCC W96

Methyl phenyl vinyl

GE 81653
DC 440
UCC X97

A Basic Discussion—continued

tween the molecules. In the case of hard rubber there is a crosslink at every monomer unit; in butyl rubber, at nearly every unsaturated bond. Soft vulcanized silicone rubber has about one crosslink for each 400 to 600 monomer units. The links act like spot welds between chains, giving the rubber permanent snap or bounce. They prevent slippage of the chains under pressure, and anchor them so that they will return to their original configurations after compression or extension.

Vulcanization changes the physical form of the rubber from a molasses-like solid to an elastic gel. The same change occurs in all rubbers, as well as in many plastics. In silicone rubber the reaction is carried out by heating 10 to 30 min at 200 to 350 F, followed by postcuring either at 480 F or at a gradually rising temperature up to 480 F. The postcure gets rid of uncrosslinked molecules and undesirable reaction products, and probably also stabilizes the entire structure by minor rearrangements that are difficult to identify.

Silicones, like other rubbers, can also be vulcanized by hard x-rays or gamma rays. Radiation presumably knocks hydrogen atoms off the side chains, permitting carbon atoms to link up.

How they're reinforced

The term "reinforcement" as used here denotes the sum of a number of things, such as the thickening effect a filler has on a liquid, the improvement in cohesion provided by use of a filler, the chemical combination of filler and polymer, and the effect of a filler on crystallization forces.

The primary effect of fillers is to stiffen the product. In silicone rubbers, as well as some of the other synthetic rubbers, the filler seems to have a grater affinity for the rubber than the rubber does for itself. As a result, not only are the stiffness, strength and tear resistance improved, but also elongation is raised—from about 100% in unreinforced stocks to 200-800% in reinforced stocks. Tensile strength is raised, depending on the filler used, from 25 psi to 300-2000 psi.

For natural rubbers, only carbon black, clays and silicas are considered to be reinforcing agents. Carbon black is of little use in silicone rubber except for producing electrically conductive stocks. Though almost all fillers reinforce silicone rubber to a degree, silica is the most satisfactory. This is partly because the silica particles are porous, permitting the fluid silcone to penetrate thoroughly, and partly because silicas can be obtained as very fine particles, 10 to 50 millimicrons in diameter.

How compounds are modified

During the compounding of the silicone rubber stock, additives can be used to further modify the properties of the rubber. The most important additives are mercury, cadmium or organic additives, such as the quinones, which are called compression set additives. They serve to clean up residual peroxide linkages on the side chains, making the side chains no longer reactive. If this is not done, further vulcanization will take place during compression set tests, and permanent set will result.

With certain silica fillers, compounders use an "antistructure" agent which retards formation of "bound rubber" (rubber bound to silica so that it does not vulcanize properly) until after the product has been molded or cured. With the alkoxy coated silica it is desirable to control the disappearance of the organic coating by adding antioxidants similar to those used in natural rubber to retard oxidation.

PROPERTIES OF THE NEW STEEL—TREATED AND UNTREATED

Material	Temper Temp, F[a]	Tensile Strength, 1000 psi	Yield Strength (0.2%), 1000 psi	Elongation (in 1.4 in.), %	Reduction of Area, %	Rockwell Hardness	Charpy Impact Strength, (V-notch), ft-lb	
							70 F	40 F
Untreated Steels[b]	400	290	235	9.5	36	C54	17.2	16.5
	450	288	235	10.0	35	C53	18.4	18.6
	500	287	239	9.8	37	C54	16.8	17.7
Boron Treated Steels[c]	400	292	234	9.7	34	C54	14.8	15.2
	450	289	234	9.2	35	C53	19.0	15.6
	500	289	240	8.7	33	C54	14.5	16.6
Vacuum Remelted Steel[d]	400	292	236	11.2	46	C53	18.8	18.2
	450	289	242	10.8	48	C53	21.1	19.1
	500	293	246	11.0	47	C53	18.5	18.8

[a] All steels oil quenched from 1650 F, double tempered as indicated. Critical points determined on two compositions: Ac_3, 1600 F; Ar_3, 1350 F; Ms, 540 F.

[b] Avg of four steels ranging in composition as follows: 0.38-0.42 C, 0.76-0.79 Mn, 0.005-0.008 P, 0.016-0.020 S, 1.59-1.6 Si, 1.83-1.9 Ni, 0.79-0.85 Cr, 0.25-0.31 Mo, 0.041-0.08 Ti, 0.009 O, 0.008 N, 0.001 H.

[c] Avg of three steels having composition as follows: 0.39-0.43 C, 0.72 Mn, 0.007 P, 0.028 S, 1.5 Si, 1.8 Ni, 0.83 Cr, 0.30 Mo, 0.04-0.08 Ti, 0.0011-0.0021 B, 0.009 N.

[d] Composition: 0.35 C, 0.57 Mn, 0.005 P, 0.014 S, 1.56 Si, 1.84 Ni, 0.85 Cr, 0.31 Mo, 0.08 Ti, 0.001 O, 0.006 N, nil H.

New Ultra High Strength Steel

A high silicon, titanium modification of 4340 retains ductility for structural applications when heat treated to a strength of 285,000 psi.

by Samuel J. Rosenberg and Carolyn R. Irish, *Metallurgists, National Bureau of Standards*

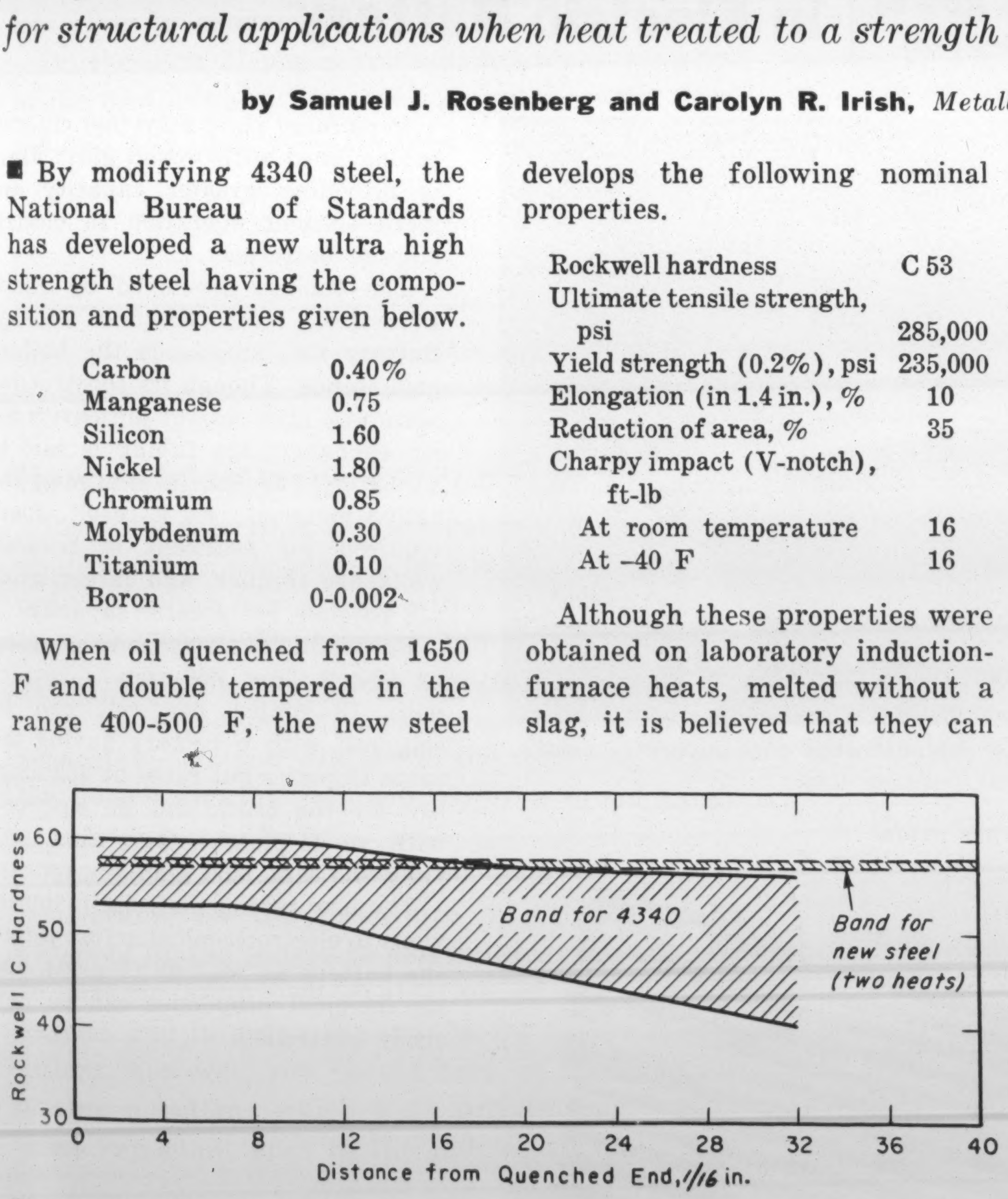
■ By modifying 4340 steel, the National Bureau of Standards has developed a new ultra high strength steel having the composition and properties given below.

Carbon	0.40%
Manganese	0.75
Silicon	1.60
Nickel	1.80
Chromium	0.85
Molybdenum	0.30
Titanium	0.10
Boron	0-0.002

When oil quenched from 1650 F and double tempered in the range 400-500 F, the new steel develops the following nominal properties.

Rockwell hardness	C 53
Ultimate tensile strength, psi	285,000
Yield strength (0.2%), psi	235,000
Elongation (in 1.4 in.), %	10
Reduction of area, %	35
Charpy impact (V-notch), ft-lb	
At room temperature	16
At -40 F	16

Although these properties were obtained on laboratory induction-furnace heats, melted without a slag, it is believed that they can be duplicated or improved in well made commercial steels.



End quench hardenability *band for the new steel.*

Background

Type 4340 steel has been used successfully to meet relatively high strength requirements for aircraft. Therefore, when the Bureau was requested to develop a ductile steel with higher properties, development centered on modifications of 4340. Boron was investigated because previous work at the Bureau showed its beneficial effects on low temperature impact properties of high strength steels. Since the effect of boron is often lost unless nitrogen is tied up as a compound, titanium was selected to combine with the nitrogen.

A series of modifications of 4340 was prepared. Each heat was split into two parts. After pouring the first ingot, boron was added before pouring the second. The ingots were hot rolled into plate for testing.

Six different hardening treatments were investigated to determine the effects of heat treatment on properties; no treatment showed consistent superiority over another. Therefore, a straight quench with double temper was used for subsequent investigations, since this heat treatment gives the best impact values both at room temperature and at −40 F.

Following the exploratory investigations of the effects of boron content and heat treatment, additional melts were made of the composition giving the best combination of strength and ductility. Average mechanical properties, determined on longitudinal samples of this group of melts, showed little difference between boron-free steels and their boron-treated modifications. Impact tests run on a number of transverse specimens gave values above 11 ft-lb at room temperature and at −40 F.

Vacuum remelting of one heat resulted in loss of carbon and manganese, a decrease in oxygen and elimination of hydrogen. However, microscopic examination showed that the steel was no cleaner than the original material. This steel was somewhat superior to the others in mechanical properties, particularly in ductility.

Acknowledgment

The vacuum remelt was prepared by Mallory-Sharon Corp.

References

Digges, Thomas G. Irish, Carolyn R., and Carwile, Nesbit L., "Effect of Boron on the Hardenability of High-Purity Alloys and Commercial Steels," *Jnl. Research NBS*, vol. 41, 1948, p 545.

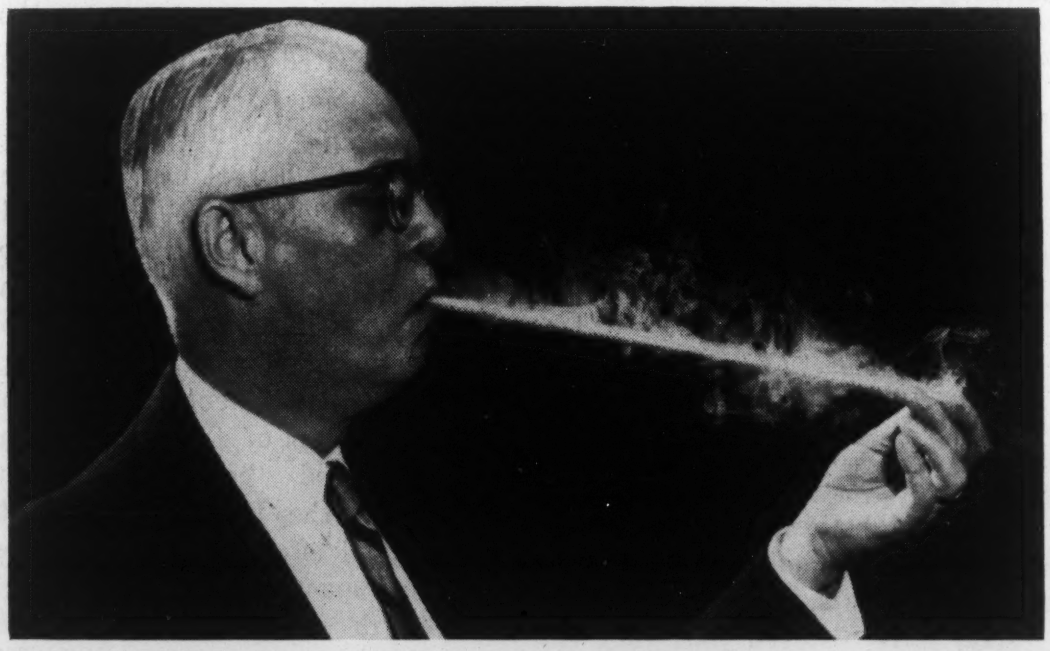
Rosenberg, Samual J., and Grimsley, John D., "A Study of the Impact Properties of Boron-Treated Steels," *Jnl. Iron and Steel Inst.*, vol. 182, 1956, p 278.

Editor's Note

Properties of a number of ultra high strength steels have been discussed in MATERIALS & METHODS (Oct '54 and Mar '56). Many of these steels are modifications of the basic 4340 steel so widely used in aircraft. It is not surprising, therefore, that steels developed independently may resemble each other quite closely in composition, as shown:

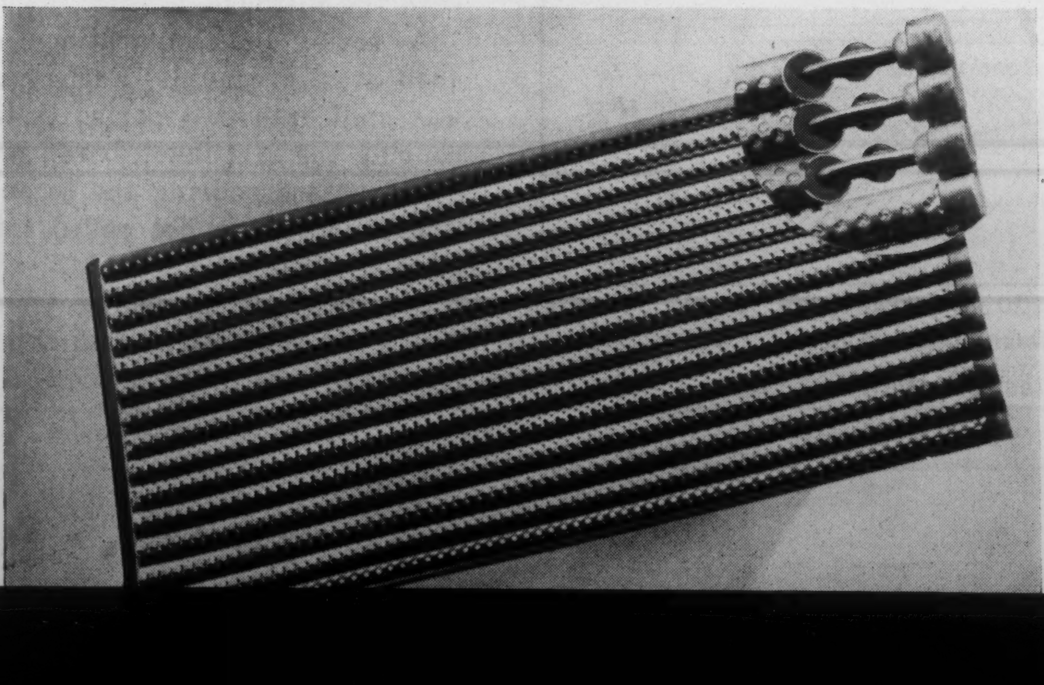
	NBS	Tricent
C	0.40	0.43
Mn	0.75	0.80
Si	1.60	1.60
Ni	1.80	1.83
Cr	0.85	0.85
Mo	0.30	0.38
V	—	0.08
Ti	0.10	—
B	0.0-0.002	—

PVC + Glass [more power less space] in Electric Battery



High porosity *of new PVC tubing is demonstrated with cigarette smoke.*

Thin walls *of PVC tubing permit larger grids.*



Perforated rigid polyvinyl chloride tubing lined with woven glass fibers is providing greater capacity and more efficient operation in electric storage batteries.

The tubing, developed by Exide Industrial Div., Electric Storage Battery Co., surrounds the battery grid spines. Though its construction permits a high rate of diffusivity for ion exchange, the tubing is said to be highly efficient in retaining the active material. As a result, space required for sediment is reduced, walls are thinner, and larger grids are possible for greater capacity.

For example, a 2000-lb truck using an 18-cell, 36-v, 360-amp-hr battery with 13 plates per cell can be equipped with a battery having the same 13 plates but rated at 432 amp-hr. Or the truck can be equipped with an 11-plate battery that provides the same 360 amp-hr capacity.

The new tubing material is impervious to electrochemical action within the battery as well as to acids, and its chemical properties can be precisely controlled.

FIRST ANNUAL
Materials & Methods
AWARDS COMPETITION
for the Best Use of Materials
in Product Design

AWARD WINNERS

Sixteen winning product designs

show sound and progressive use of engineering materials

The over-all objective of this magazine is to encourage sound, imaginative and progressive use of engineering materials in the design and redesign of industrial and consumer products. To exemplify and pursue this objective we inaugurated last year an annual MATERIALS & METHODS Awards Competition, the prizes to be awarded for "best use of materials in product design."

On the next 27 pages you will learn the winners of the first competition, and you will see what they did and why they won. We believe that most of you will get some ideas for your own products.

From the time we first announced the competition last November until the final deadline for entries in mid-February, we received more than 150 entries for this competition—a response we found particularly gratifying in view of the newness of the competition. Although we have awarded a total of only 16 prizes, the number of entries of high quality was considerably higher. Many of the nonwinning entries will be published in MATERIALS & METHODS during the coming year.

How entries were judged

Products entered in this competition ranged from small parts or components to large assemblies. In order to insure fair consideration of entries requiring a smaller scale of design and development, the judges split all entries into two groups, depending upon their complexity, and evaluated each group separately. As you will see in the following pages, the award-winning products cover a broad range of size and complexity.

The editors of this magazine imposed no rigid restrictions on the procedure or criteria to be observed by the judges in determining the winners. In making your own evaluation of the winning entries and in preparing entries for future competitions, however, you should keep in mind the following questions which were certainly among the most important ones in the judges' minds as they approached and evaluated the entries:

1. How important was materials selection in the development of this design?
2. On the basis of the information submitted, how competent and thorough was the approach to selecting the materials?
3. If entry is a first design (new product), how well did the selection of materials meet the design and service requirements?
4. If entry is a redesign, how valuable were the benefits gained through improved materials selection.
5. How significant is this entry in terms of encouraging sound, imaginative and progressive use of engineering materials, and will it set or encourage a new trend in the use of materials?

Awards for the entries that best withstood these tests are listed on the next two pages.

Here are the award winners...

FIRST AWARD

$500 and plaque

F. L. Talcott, *Manager*
Refrigerator-Freezer Design Section
Westinghouse Electric Corp., Columbus, Ohio

Developing a new basic design for refrigerator walls through the sound and imaginative use of plastics foam sandwich construction.

AWARDS OF MERIT

$100 and certificate

RICHARD M. KLAUS, *Project Engineer*
OPW Corp., Cincinnati, Ohio

Redesign of insertable union check valve making unique use of newer materials to achieve improved performance and lower cost.

ELMER W. CONKLIN, *Research Engineer*
Durametallic Corp., Kalamazoo, Mich.

Comprehensive engineering and testing program leading to the selection of alumina ceramics for seal rings used in mechanical rotary seals.

EDWARD A. STRATE, *Armament Design Engineer,*
HARLAN A. REESING, *Production Design Engineer, and*
PERRY D. GOLDBERG, *Materials & Process Metallurgist*
El Segundo Div., Douglas Aircraft Co., Inc., El Segundo, Calif.

Design of breech for aircraft bomb ejector rack using a forged and heat treated titanium alloy to improve performance and reliability.

W. F. OLASHAW and A. H. ADAMS, *Design Engineers*
Distribution Assemblies Dept., General Electric Co., Plainville, Conn.

Redesign of back connected stud assembly for a switchboard using new materials to improve performance and reduce cost.

R. E. NEARMAN, *Project Engineer*
Washington Technological Associates, Inc., Rockville, Md.

Complete redesign of sanitary fixture replacing the major metal components with glass fiber-reinforced plastics moldings to simplify fabrication and improve usefulness and appearance.

CITATIONS

$50 and certificate

JOHN D. BACHMAN, *President*
John D. Bachman & Co., Bristol, Tenn.

Redesign of a low pressure, direct acting control valve using laminated plastics and anodized aluminum to improve performance and reduce cost.

JAN A. RAJCHMAN and CHANDLER WENTWORTH,
Members of Technical Staff
RCA Laboratories, Princeton, N. J.

Development of a molded ferrite apertured memory plate with printed winding which opens the way to major advances in speed and efficiency of electronic computers and data processing systems.

ENGINEERING SECTION, *Instrument Dept.*
General Electric Co., West Lynn, Mass.

Completely new design of an outdoor high voltage instrument transformer which embeds the entire unit in a specially developed nontracking butyl rubber.

CARL A. MILLER, *Physicist*
Economics Laboratory, Inc., St. Paul, Minn.

Sound selection and imaginative use of materials in design of a new rinse injector device for a commercial dishwasher.

RESEARCH & DEVELOPMENT DIV.
A. O. Smith Corp., Milwaukee, Wis.

Use of glass-coated steel in the construction of industrial smokestacks to provide significantly longer life and greatly reduced maintenance costs.

F. E. COOK, *Materials Engineer,*
H. S. PREISER, *Corrosion Engineer*
Bureau of Ships, Navy Dept., Washington, D. C.

Design of an improved and less expensive holder for graphite anodes used in cathodic protection of ship hulls.

CURTIS MORLING and JOHN BELLINGER,
Project Engineers
Inland Testing Laboratories Div., Cook Electric Co., Morton Grove, Ill.

A comprehensive and thorough program to select the best materials for frames, boards and cabled leads used in environmental chambers for testing electronic components.

HARLAN A. REESING, *Production Design Engineer,*
JAMES G. QUINN, *Design Specialist—Structures, and*
PERRY D. GOLDBERG, *Materials & Process Metallurgist*
El Segundo Div., Douglas Aircraft Co., Inc., El Segundo, Calif.

Design of slat track for military jet airplane using a heat treated titanium alloy to reduce weight and improve service performance.

JOSEPH H. GETTIG, *President*
Gettig Engineering & Mfg. Co., Spring Mills, Pa.

Imaginative and efficient use of many different engineering materials in the design of a toxic fume exhaust system.

M. R. KAUFFMAN, *Project Engineer*
Dishwasher and Disposal Dept., General Electric Co., Louisville, Ky.

Redesign of a portable dishwasher in which use of a plastisol coating has made possible single-wall construction.

. . . and here is what the judges say about the entries

Teague:

"The case histories examined by me impressed me by the almost invariably high quality of the engineering thinking they displayed. They revealed intelligent solutions of problems having to do with the selection and use of materials, and emphasized the great expansion in the range of materials now available to design engineers.

"However, many entries represented an intelligent but rather obvious solution of an engineering problem. That is, when it is time to redesign a product or component which has not undergone any change for a number of years, it is to be expected that the engineer will take advantage of the new materials that have become available during this lapse of time, and that have obvious advantages over the materials that were standard at the time of the original design.

"If, under these circumstances, a design engineer did not look around him and avail himself of the new resources that research and development have placed at his disposal, you would give him a very black mark for either laziness or incompetence. But if he merely makes a logical substitution, you don't consider him necessarily worthy of a gold star for exceptional achievement. What impressed me and, I am sure, the other judges most, were occasional unexpectedly imaginative uses of materials, beyond the range of selection clearly indicated by the present state of technology."

WALTER DORWIN TEAGUE
Industrial Designer
Walter Dorwin Teague Associates

Seastone:

"Generally, we were much impressed by the ingenuity and understanding of materials exhibited by the contestants. Many of the designs were cleverly worked out to take advantage of the new or more desirable characteristics of the materials employed, and conversely, to minimize the importance of less favorable properties.

"Information submitted with the entries suggested, in general, that the selection of materials might have been somewhat intuitive; i.e., the final choice of materials seemed to be based on a general feel for the situation rather than on a documented review of the properties of alternative materials.

"It was, of course, difficult to rate the entries with respect to each other because they were of such diverse character. Some were simple parts; others were complex mechanisms involving a wide range of design considerations and many materials and processes. Although the complexity of the problem was considered in the final rating, greatest weight was given to the sound and imaginative selection of materials and to the importance of this consideration in the end product."

JOHN B. SEASTONE
Director, Technical Div.
Olin Mathieson Chemical Corp.

Nielsen:

"In going over the various entries, I found that a pattern of the materials selection process emerged in the most successful entries. The outstanding characteristic of the pattern is that one comes to the final solution by a process of successive approximations. A design is tentative until a tentative material is selected, whereupon the design can be made more specific. The more specific design permits more precise materials selection, and by a continuation of this successive approximation approach a final design and material are established. Two important prerequisites for sound selection by this process, however, are: 1) a thorough analysis of the requirements that must be met by the material, and 2) careful, progressive elimination of unsuitable materials as the requirements become more precise.

"Only in a few cases did the entries in this competition show a fairly sound approach to materials selection; the majority showed a weak approach. Frequently, in the poorer approaches, only one or two requirements for the material were listed. Also, in many cases, once the requirements were established, the final material was arrived at not by elimination, but by summary dismissal of all materials but one. Many eligible materials must have been dismissed because of this lack of thoroughness."

JOHN P. NIELSEN
Chairman
Dept. of Metallurgical Engineering
New York University

The judges—*Left to right: Nielsen, Teague, Bonanno and Seastone. Center, M&M Editor Clauser.*

Bonanno:

"I was pleased to see so many well documented reports of tests, production data, performance comparisons and ultimate costs of products. Several of these reports, in fact, were so well documented as to constitute important engineering contributions. Needless to say, the type of entry in which a careful solution of a material problem might have far reaching influence on the future, in that or related industries, was given major consideration.

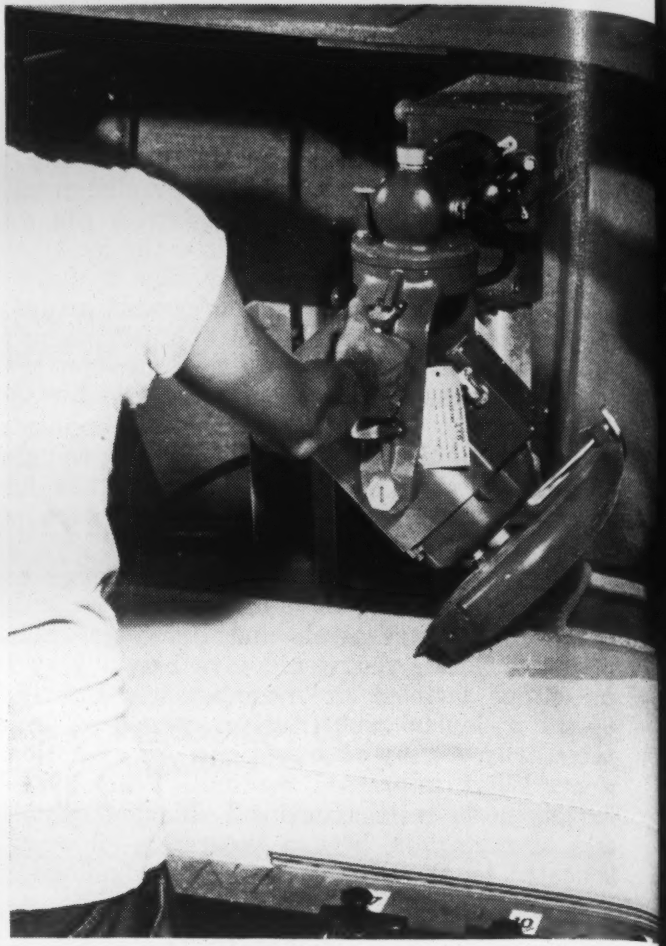
"Quite a few of the entrants failed to realize that the prime object of the competition was to bring forth thinking involved in the selection of materials, careful step-by-step consideration of the numerous materials available to the designer today, and the judgment used in determining the usability of any specific material. In many cases, the entrant apparently decided on the material without an exhaustive consideration of the numerous possibilities, basing his choice on considerations other than optimum performance.

"In many cases, the choice of materials was dictated by existing production facilities, which is a valid consideration, though not conducive to inspired design or setting new trends in material utilization. Also, a number of entrants had to be eliminated on the basis that the material cosiderations were secondary and styling was of paramount importance in the redesign."

JOSEPH L. BONANNO
Chief Engineer
Lionel Corp.

How the foam is used

1 **Sandwich panel is made.** *The panel, 14 ft long, is made by bonding inner and outer faces to the polystyrene foam core with an epoxy adhesive. Quantities of these sandwiches are stacked and cured in a press.*



2 **Notches are cut.** *Ordinary woodworking saws are used to cut notches for forming the corners.*

Plastics Foam Sandwich

FIRST AWARD

F. L. TALCOTT

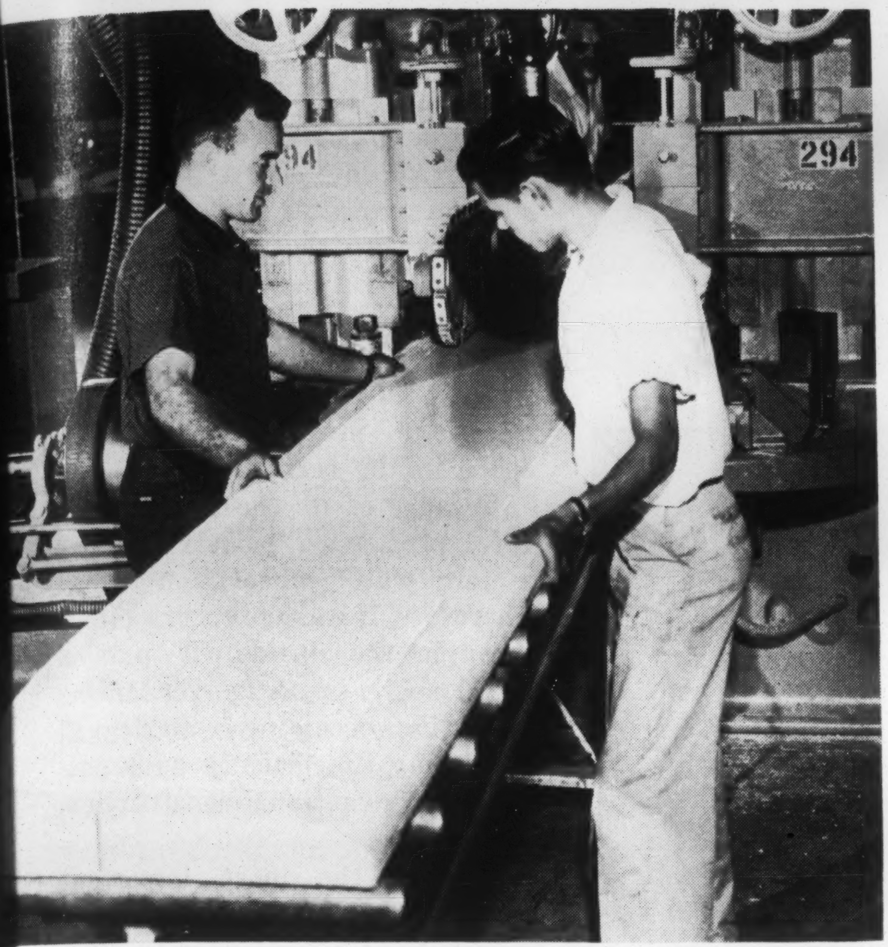
Manager, Refrigerator-Freezer Design Section
Westinghouse Electric Corp.

Developing a new basic design for refrigerator walls through the sound and imaginative use of plastics foam sandwich construction.

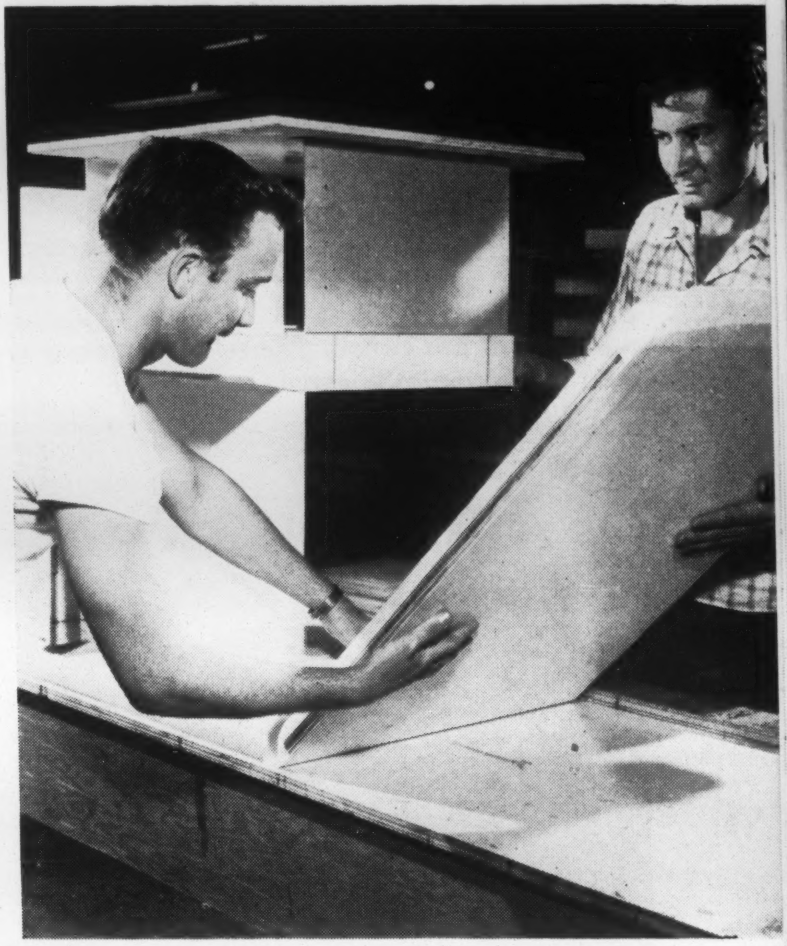
The Winner

F. L. Talcott, 37, graduated as a mechanical engineer from Stevens Institute of Technology in 1942. He joined Westinghouse's graduate student training program and was transferred to the Refrigerator-Cabinet Engineering Dept. at Mansfield, Ohio, the same year. In 1954, Mr. Talcott moved to Columbus when all refrigerator and freezer engineering was consolidated there. He was promoted to his present position in 1955.

Mr. Talcott is a member of the Columbus chapter of the American Society of Refrigerating Engineers. He is married and has four children.



3 ***Edges are shaped.*** *Front and back edges of the wrapper sheet are shaped simultaneously in this double end tennoner. Cutting both edges at once assures uniformity of size and shape.*



4 ***Panel is folded.*** *The grooved sandwich edges are covered with epoxy resin and the panel formed to box shape as though it were a cardboard carton. Transverse members fit into the grooves.*

Used for Refrigerator Walls

■ A completely new design concept for refrigerator structures has been developed using plastics foam sandwich materials instead of conventional sheet metal construction. Many advantages have resulted; the two principal ones are a six-fold reduction in tooling costs and a significant reduction in weight.

The basic concept is the construction of refrigerator cabinets by simply cutting long lengths of plastic sandwich to proper size and folding them to form the walls of the refrigerator. The core of the sandwich is a rigid foam plastic which provides insulation and rigidity. The sandwich faces, which form the inner and outer surfaces of the cabinet walls, can be of any sheet material having the desired characteristics for the application.

Materials

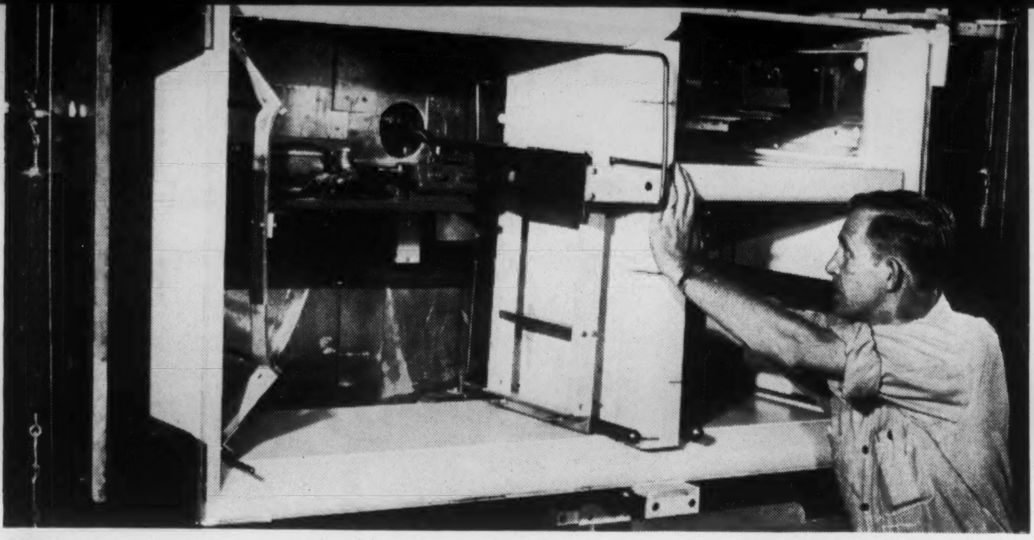
The sandwich being used at present is composed of an inner face of 0.060-in. extruded high impact polystyrene sheet, a 3-in. core of fire-retardant grade polystyrene foam, and an outer face of 0.018-in. polyester-impregnated fiberglass cloth. The polystyrene core is prefoamed and has a density of 2 lb per cu ft. Properties of the foam are given in the accompanying table.

The coefficient of thermal conductivity of the foam is 0.34, as compared to about 0.26 for fiber-

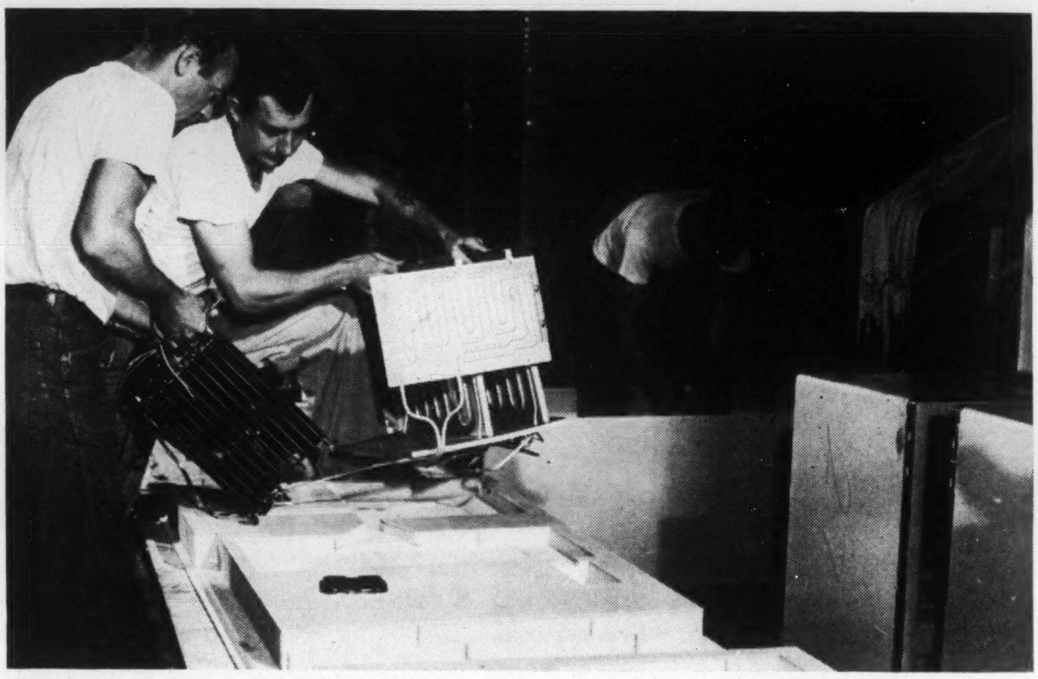
PROPERTIES OF PREFOAMED POLYSTYRENE[a]

Compressive Yield Strength, psi	16-38
Tensile Strength, psi	65-95
Shear Strength, psi	30-40
Compressive Modulus, psi	1500-2000
Bending Modulus, psi	1250-1760
Modulus of Rigidity, psi	1000-1300
Ther Cond (40 F), BTU/hr/sq ft/°F/in.	0.23-0.27
Coef of Ther Exp (0-80 F), in./in./F	$3\text{-}4 \times 10^{-5}$
Specific Heat (40 F), BTU/lb/°F	0.27
Water Absorption (1 wk), lb/sq ft	<0.15
Water Vapor Trans, gm/sq ft/hr/in./in. Hg	1.0-2.0

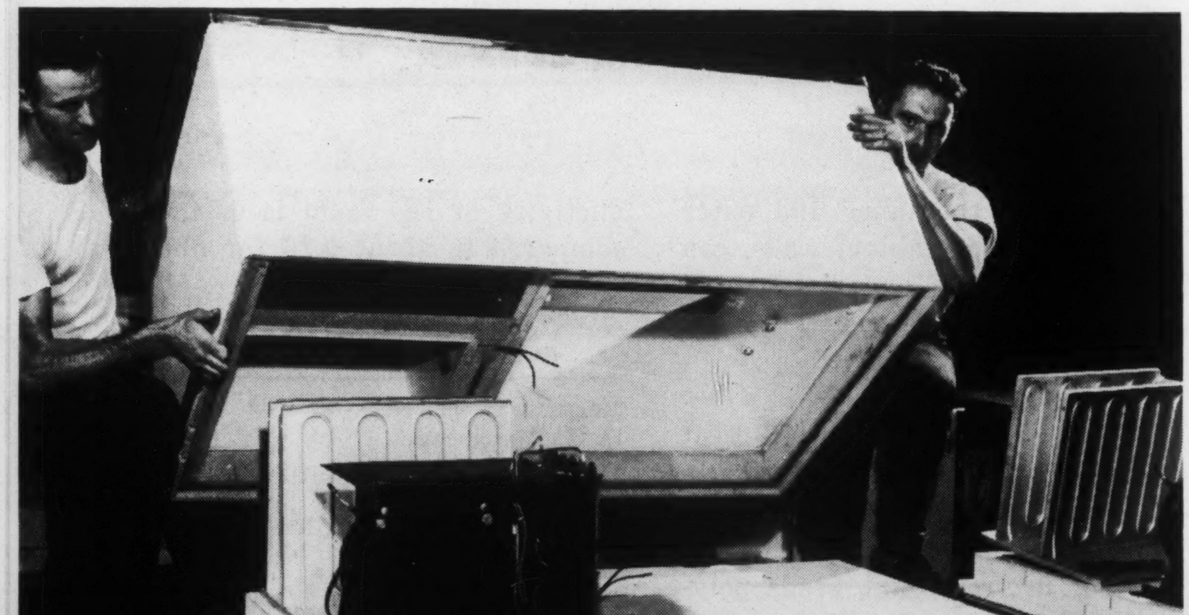
[a] Styrofoam #33. Properties are given for density range of 1.7-2.3 lb per cu ft. Data supplied by Dow Chemical Co.



5 **Joints are cured.** *The folded structure is placed in a jig and the epoxy resin is electronically cured.*



6 **Refrigerating unit is inserted.** *It is assembled to sandwich panel that forms back of refrigerator. Back has been routed out to provide proper recesses for mounting evaporators and wiring.*



7 **Subassemblies are joined.** *Refrigerator wrapper sheet assembly is slipped over back assembly and fastened to complete the structural part of the refrigerator.*

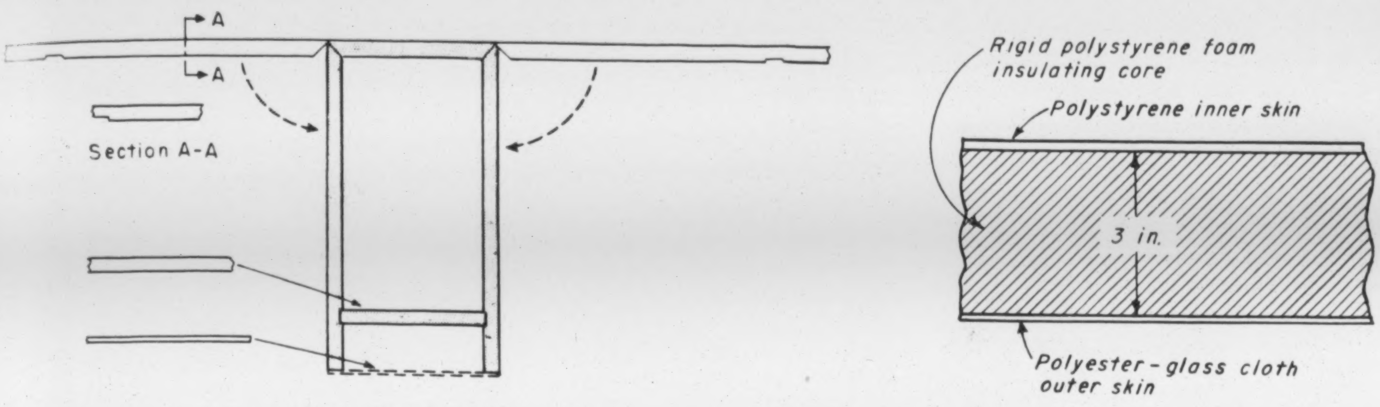
glass insulation used in conventional construction. However, because of the absence of voids, joints and dents with foam construction, its over-all insulation value approaches that of fiberglass. Recent progress in foam plastics indicates that the difference between the two types of insulation soon will be negligible, and as the insulation value of plastics foams continues to improve, wall thicknesses can be reduced to provide more usable space in the refrigerator.

Because of its closed-cell structure, prefoamed polystyrene has a low water absorption value. Therefore, if leakage occurs either through the inside or outside walls, there is no danger of the insulation becoming waterlogged and losing its efficiency as is possible in conventional construction.

Advantages

Perhaps the most important benefit derived from the new sandwich construction is the sixfold reduction in tooling costs. The two models (horizontal and vertical) currently being produced were tooled at a total cost of less than $350,000. This cost figure includes all of the interior parts, the doors and the refrigerating system. In comparison, it would have cost approximately $2,000,000 to tool these two models for conventional construction. The simple tooling also allows changes in cabinet size and/or shape to be easily and quickly made. All that is necessary to change size is to move the location of the saw cuts used for the mitered corners.

This simple, low cost tooling has provided the means for overcoming two of the refrigerator industry's basic problems: 1) the need to add to a full line of a mass produced product a few specialized models of low annual volume, and 2) the need for frequent and rapid changes in sizes and types of models to keep up with the changing requirements of kitchen arrangement and architecture. Low cost tooling also allows sales and engineering departments to determine consumer reaction to new types of models,


A
A
Section A-A
Rigid polystyrene foam insulating core
Polystyrene inner skin
3 in.
Polyester-glass cloth outer skin

***How** sandwich material (right) is bent to make walls of refrigerator cabinet.*

since a few hundred or a few thousand can be placed on the market at competitive prices.

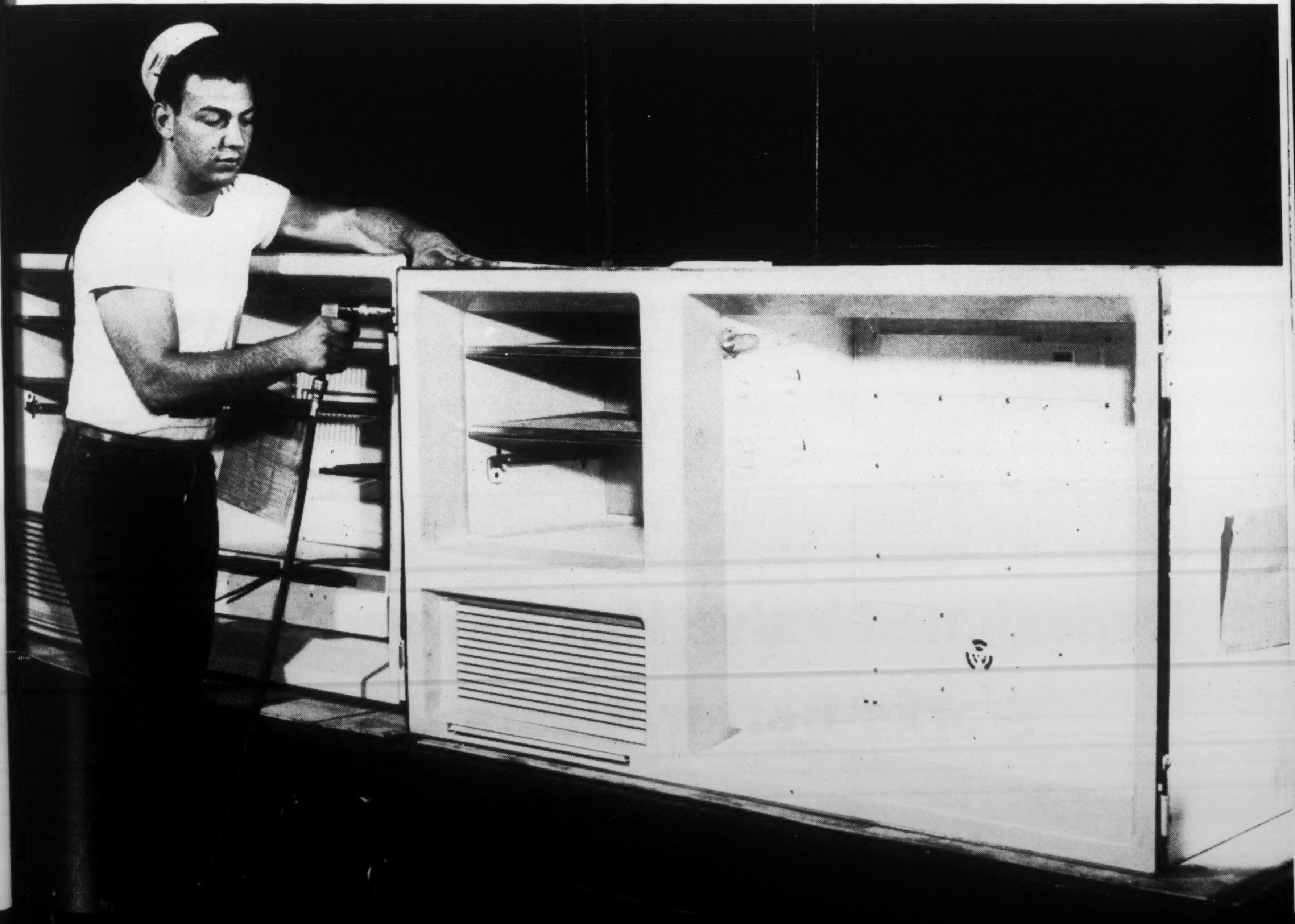
Another important benefit gained from the new sandwich construction is a sizeable reduction in weight. The new cabinet weighs only 185 lb, and the complete refrigerator weighs about 150 lb less than a comparable conventional model. This saving in weight reduces shipping costs and permits quick, easy installation.

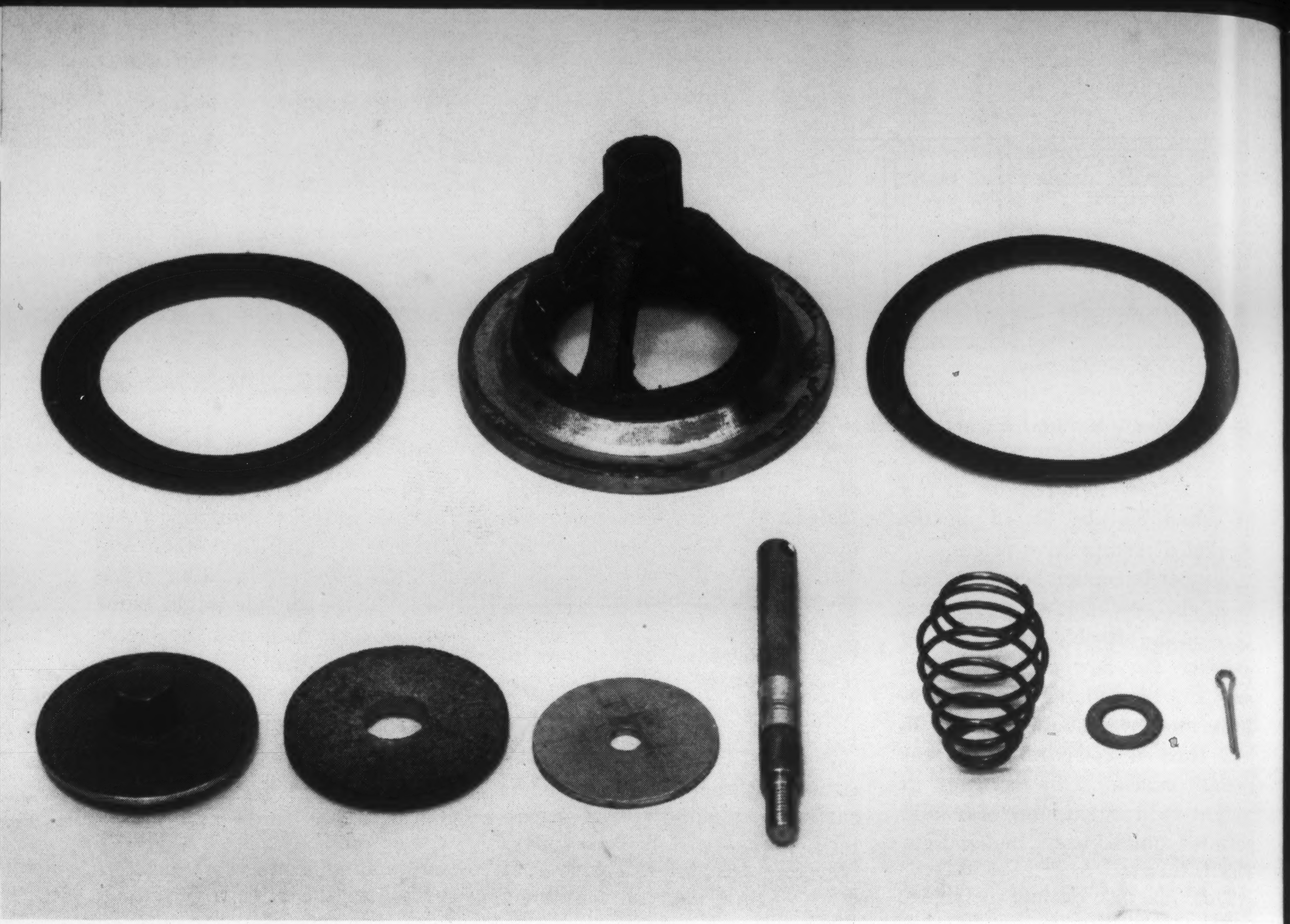
The future

This plastics cabinet refrigerator was designed, developed, tested and produced in substantial quantity by Westinghouse during 1956. At the present time, steel doors of conventional construction are being used. It is anticipated that the doors will be of sandwich construction in the near future.

These models were designed entirely for built-in applications and there was no requirement for a completely smooth, lustrous outer surface. An outer skin of polyester-impregnated fiberglass was therefore acceptable. However, it is well within the state of the art to produce refrigerators of this construction with inner and outer surfaces of countless other materials. For free-standing refrigerators, the outside might be of painted aluminum and the inside of colored anodized aluminum. Wood grain laminates or other plastics might be used for special purposes. The tops of chest freezers could be made with an outer skin of the same material as the tops of the kitchen base cabinets, thus adding extra work counter surface to the kitchen.

8 **Assembly is completed.** *Interior parts, trim and door are assembled in conventional manner.*





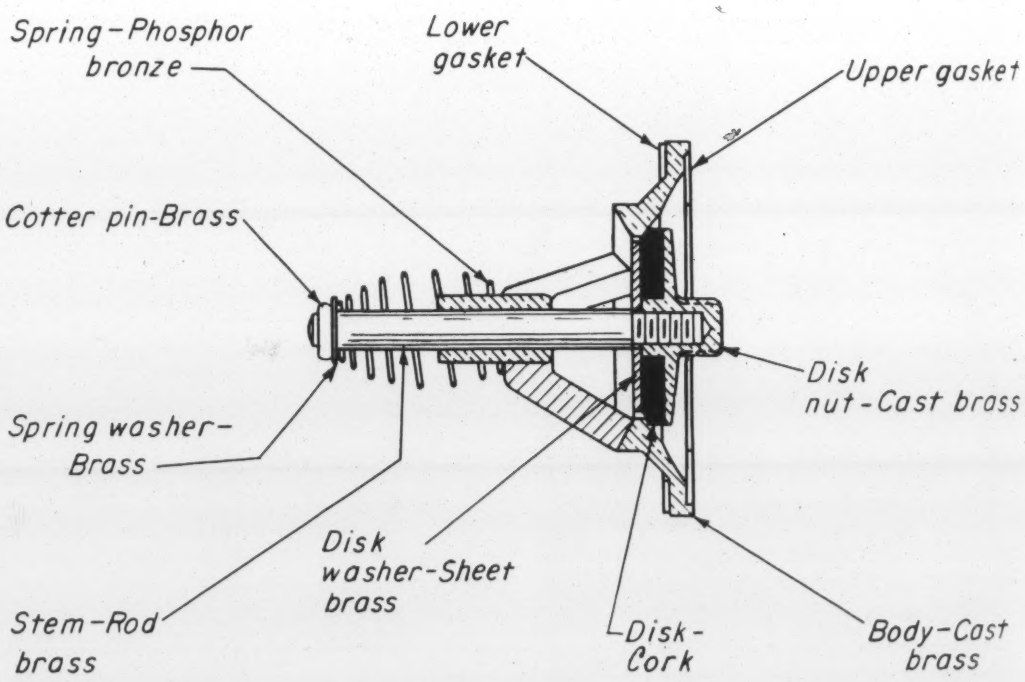
Old Design ↕

AWARD OF MERIT

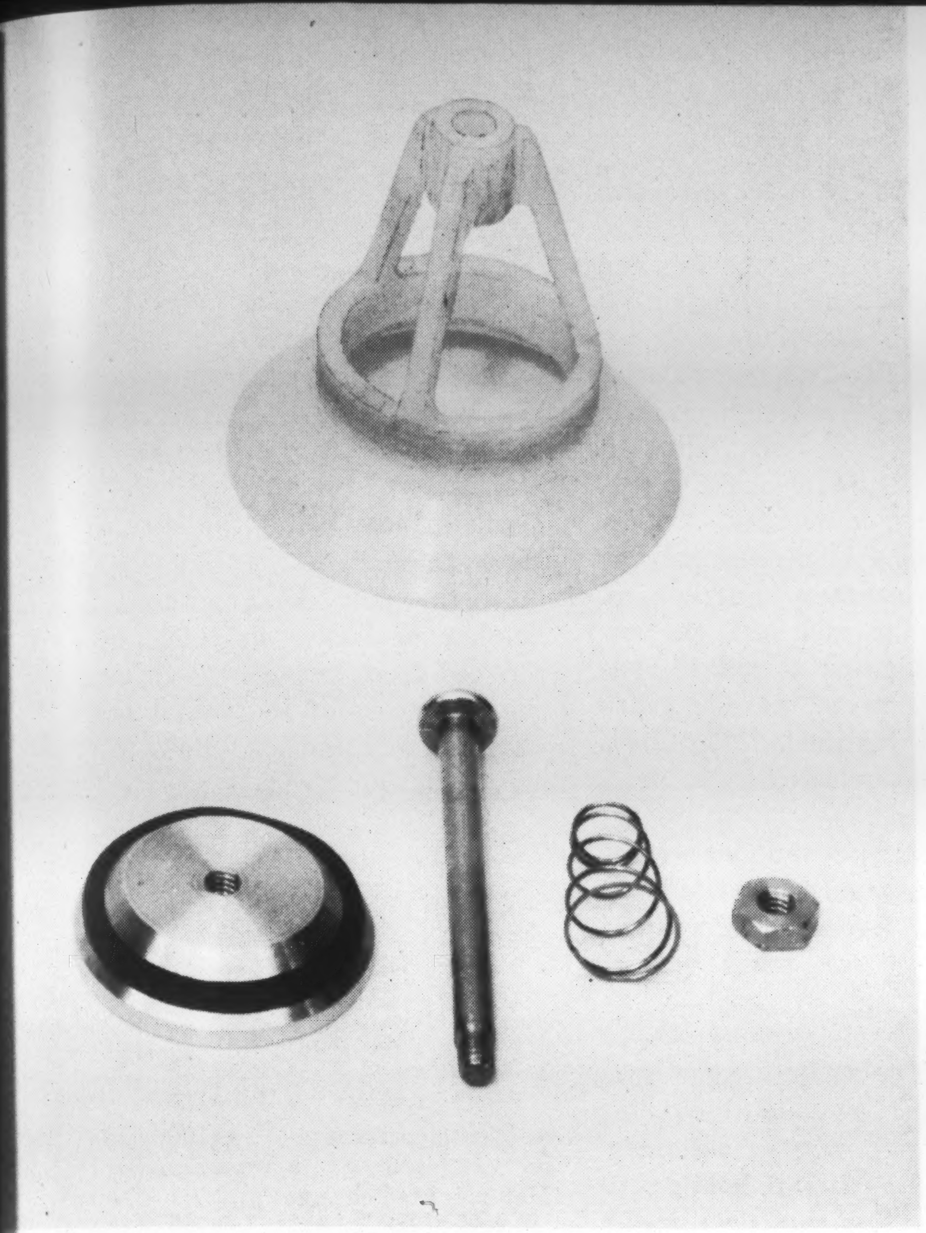
RICHARD M. KLAUS

Project Engineer,
OPW Corp.

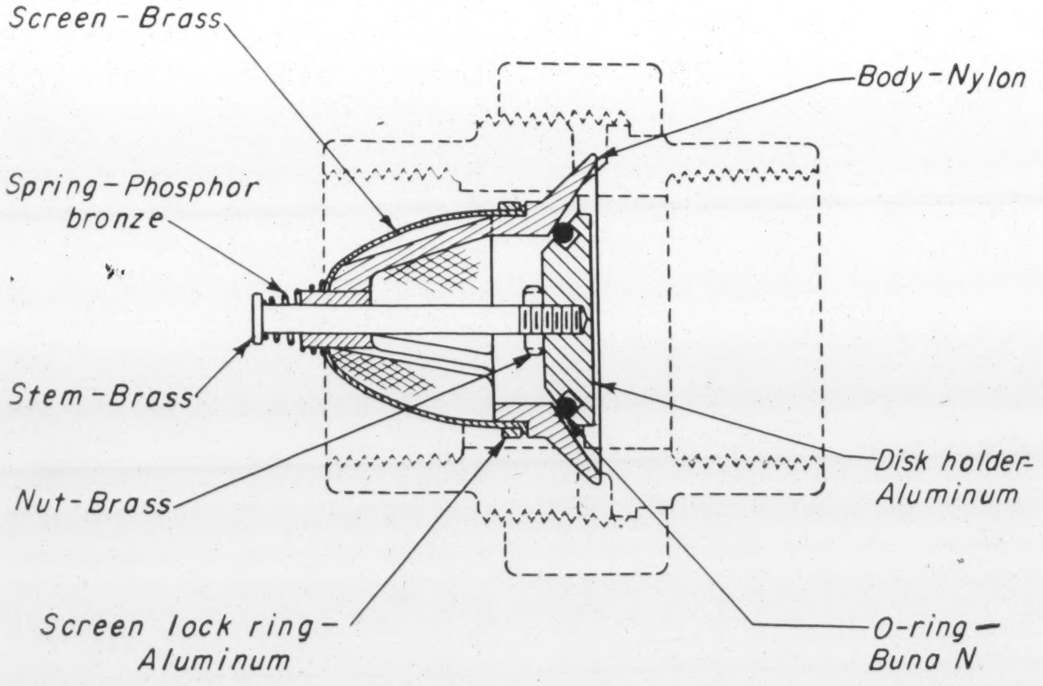
Redesign of an insertable union check valve making unique use of new materials to achieve improved performance and lower cost.


Spring-Phosphor bronze
Lower gasket
Upper gasket
Cotter pin-Brass
Disk nut-Cast brass
Spring washer-Brass
Disk washer-Sheet brass
Stem-Rod brass
Disk-Cork
Body-Cast brass

Redesigned Valve Has Fewer Parts, Works Better, Costs Less



New Design



■ An insertable union check valve is a valve that is inserted in a standard pipe union to prevent line flow of liquid in one direction while allowing flow in the opposite direction. It is installed by loosening the locking ring on a union, separating the union faces, placing the body of the check valve inside in such a way that the faces of the union rest against the body lips of the check valve, and then tightening the union locking ring until a seal is achieved. One of the main applications of this type of valve is in gasoline filling station piping.

The design requirements for this type of valve are:

1. The poppet of the valve must seal tightly to prevent seepage of air.

2. The lips of the valve body must seal tightly against the faces of all types of unions. This is a major problem because of the many different seating surface angles in unions.

3. The pressure drop through the valve must be low. Restriction on a suction line of a pump usually affects the efficiency to an even greater extent than restriction on the outlet.

4. The cost must be low because this union is a low cost substitute for a more expensive valve.

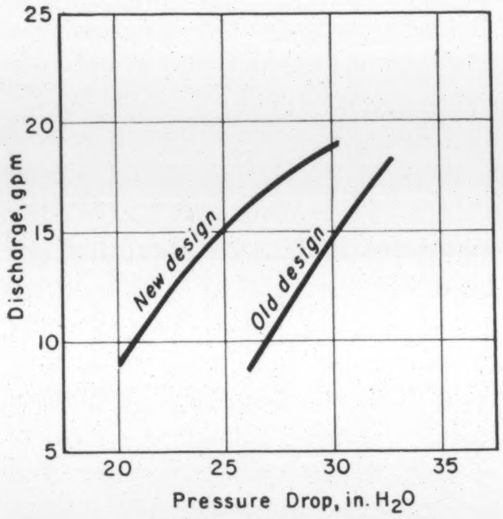
Old design

Several types of union check valves have been available for many years. The construction has been similar to that shown in an accompanying drawing — a cast brass body, cast brass disk nut, cork disk, sheet brass disk holder, brass stem, phosphor bronze spring, brass spring washer and brass cotter pin. The old design utilized a gasket both above and below the lip of the body. This gasket provided a resilient surface to compensate for any lack of line contact and for any marring of the union seat. This design was not entirely satisfactory; the thin gaskets tended to bunch under heavy tightening and occasionally were lost before installation.

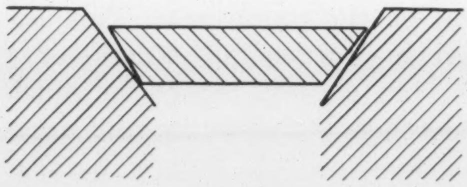
New design

Lip contact — Improvement of the lip contact was the first consideration in the redesign. The existing design proved that a resilient seat material could compensate for angularity differences. Harder gasket materials were considered. Bonded synthetic rubber, o-rings in recessed grooves and serration of the metal surface —all were reasonable designs. However, some of the plastics materials appeared to offer the best compromise between hardness and resilience. After plastics that would not withstand exposure to gasoline were eliminated, nylon of the 101 grade was selected.

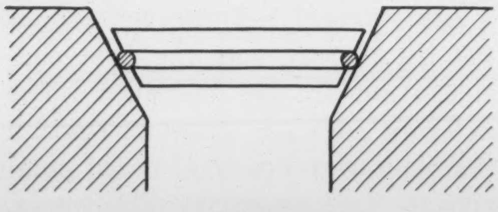
Nylon had the strength required for the basic structure combined with the low yield point necessary to ensure a tight seal under all practical conditions. It offered excellent bearing properties for the guiding of the stem. When carefully molded, nylon has a fine surface finish which is added insurance against stem friction, poor seating of the disk, improper contact of the lips, and excessive resistance to liquid flow.



Lower pressure drop *of new valve is illustrated by comparative curves for old and new 1-1/2-in. valves.*



Solid Disk



O-Ring Disk

O-ring disk ***seals much more rapidly under adverse conditions than a solid disk (top). Solid disk requires accurate control to insure concentricity and parallel contact between disks and seat faces.***

Molding offered consistent control of concentricity, angular alignment, diametrical accuracy and surface finish—not always obtainable in a machined casting.

Seal of disk—The second consideration in the redesign was the seal of the disk. For a disk to seal, only a circumferential single line contact is necessary. Therefore, resiliency is needed only at the line of contact. Further, if contact by line will seal, the expense of designing to provide accurate meeting of parallel surfaces is not justified. Therefore, an o-ring was selected to be used as the disk.

Two synthetic rubber compounds were found by test to have exceptionally low swell characteristics. These two, when soaked in popular brands of gasoline, increased in diameter only about 10%. Thus, a satisfactory disk holder could be obtained by stretching an o-ring in assembly in excess of 10% and holding it in such a position that flow would not extract it.

By experiment with model disks, the optimum angle for the retaining groove and the shape of the disk holder were determined. Because of the simple shape of the o-ring, bar stock was selected rather than a casting. Aluminum was selected as the material because it offered ease of machining, low cost and resistance to gasoline.

Stem—Because no load of consequence was carried by the stem, the diameter was changed from 1/4 in. to 3/16 in. A nut was added to lock the disk in position, and the cotter pin and spring washer were replaced by a cold formed head. The stem then resembled a rivet; therefore, a commercially available rivet was found suitable.

Spring—The large barrel shaped spring was replaced with a smaller cone shaped spring. The approximate spring loading used previously was preserved by using a smaller diameter wire and fewer coils. Actually the upward travel of the disk was reduced to preclude the theoretical possibility of the disk moving up against the pipe end in the union and thereby restricting the flow.

Screen—An addition to the new design was a screen pressed out of a flat brass sheet and punched with a hole to fit over the hub. It was retained on the larger diameter by the cone spring, and an aluminum ring pressed on the diameter just below the seat.

Advantages

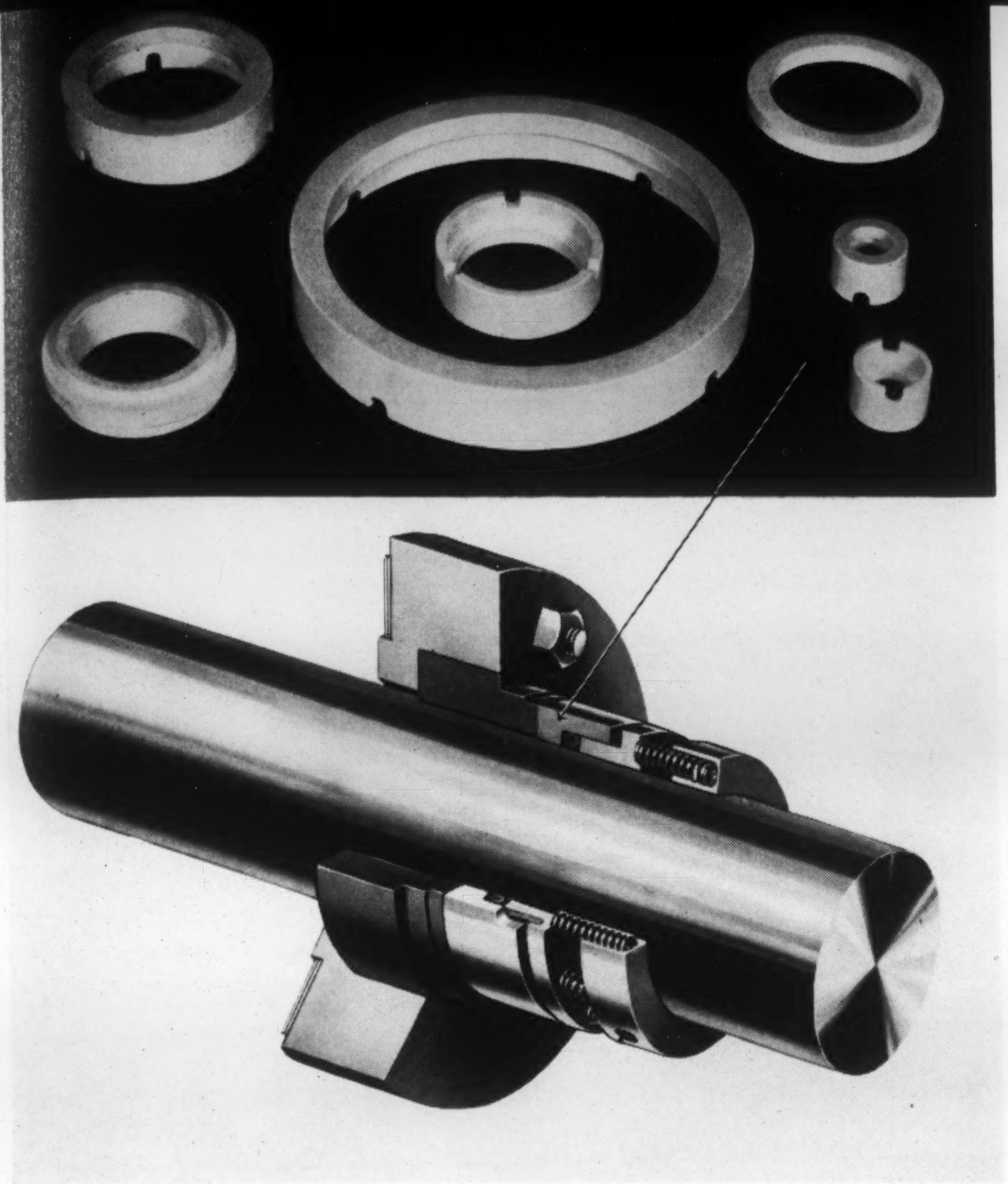
In the new design, the total number of basic parts has been reduced from ten to six. In addition, the cost of individual parts has been reduced as follows:

Component	Change in Cost, %
Body	— 70
Disk nut	— 55
Washer	— 37
Stem	— 71
Lower gasket	—100
Upper gasket	—100
Disk	+ 33
Spring	— 73
Spring washer	—100
Spring cotter pin	—100
Net weighted change in cost of basic parts	— 68

The torque required to obtain a tight seal of the union against the valve body lips ranged from about 25 to 50 lb. Yet, at 500 in.-lb only slight indentation occurred in the sealing lips. Upon retightening in a union having a different seating angle, sealing occurred at a torque under 50 in.-lb, indicating no permanent damage to body lips even when abused by excessive tightening.

The flow characteristics were notably improved in the low flow range (under 20 gal per min). For example: at 15 gal per min, the old design had a pressure drop of 31 in. H_2O, whereas the new design sustained only 25 in. H_2O. In an average pumping range, this difference in pressure drop represents a 19% reduction in pump suction loss.

The ability of the valve to hold the pump prime was measured by applying air pressure opposite to the direction of flow. Sealing occurred at less than 1 psi pressure and held up to a maximum test pressure of 80 psi with no visible damage to any parts of the valve.



***Cross section view** of standard mechanical seal showing where ceramic seal rings are used.*

AWARD OF MERIT

ELMER W. CONKLIN
Research Engineer,
Durametallic Corp.

Comprehensive engineering and testing program leading to the selection of alumina ceramics for seal rings used in mechanical rotary seals.

Ceramic Rings Used for Mechanical Rotary Seal

■ Mechanical rotary seals must be designed with materials that will meet a wide range of service conditions. One of the most critical parts in these seal mechanisms is the rotating seal ring. Extensive tests were conducted at Durametallic Corp. to find materials that would perform satisfactorily where metal seal rings and facings could not meet service conditions.

These tests revealed that alumina ceramics make superior rotating seal rings for a large variety of applications. The rings can be made completely of the ceramic, or the ceramic can be overlaid on a ring of a different material.

Solid ceramic rings

A number of different shapes and sizes of ceramic seal rings have been designed for use in Durametallic's mechanical rotary seals. They fit over shafts ranging from ¼ in. up to 6 in. dia. Some of the principal properties of alumina ceramics that make them suitable for seal rings:

1. Their high hardness provides superior resistance to wear and abrasion.

2. They have excellent resistance to all commercial acids except hydrofluoric acid and strong caustic solutions.

3. They retain full strength up to 2000 F and will support their own weight and maintain shape up to 3000 F.

4. They cost less than other sealing materials, except bronze and plated steel.

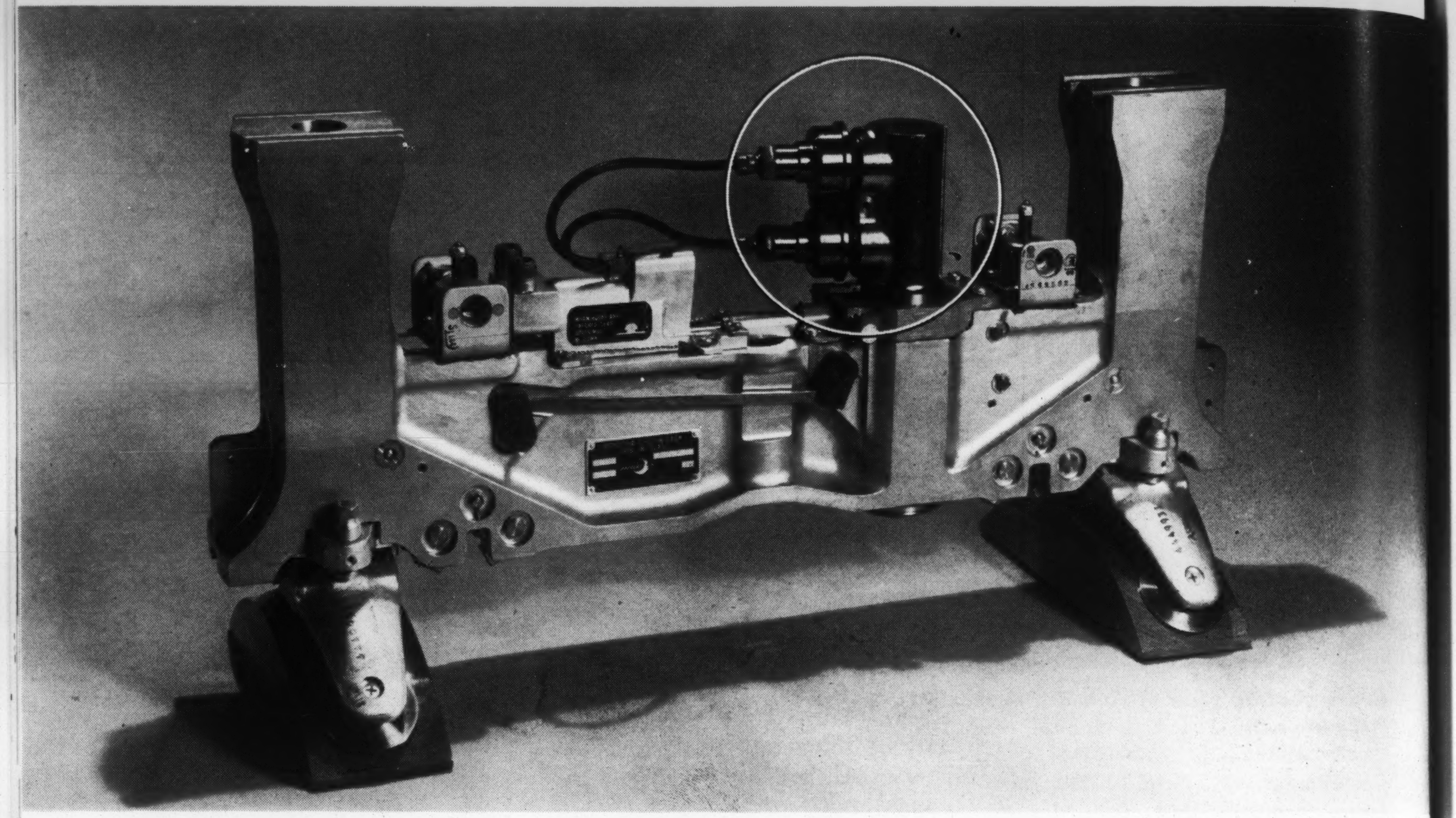
Ceramic overlays

Ceramic overlay seal facings are applied by the flame spraying method developed at Norton Co. The facing is usually 0.015 to 0.020 in. thick and can be applied to various ferrous and nonferrous metals and to carbon.

Ceramic faced seal rings have proved successful in certain applications where solid ceramic cannot be used. Ceramic faced rings will withstand greater thermal shock than solid ceramics. They also are useful for high speed applications (8000-20,000 rpm) and for high pressure uses. Another advantage is that seal rings can be of more complex design than is possible with solid ceramic.

This entry will be published in full in a future issue of MATERIALS & METHODS.

Titanium Used for Breech of Bomb Ejector Rack



Forged titanium breech *(circled part) is used in bomb ejector rack for high speed aircraft. Photo below shows breech before (left) and after (right) machining.*

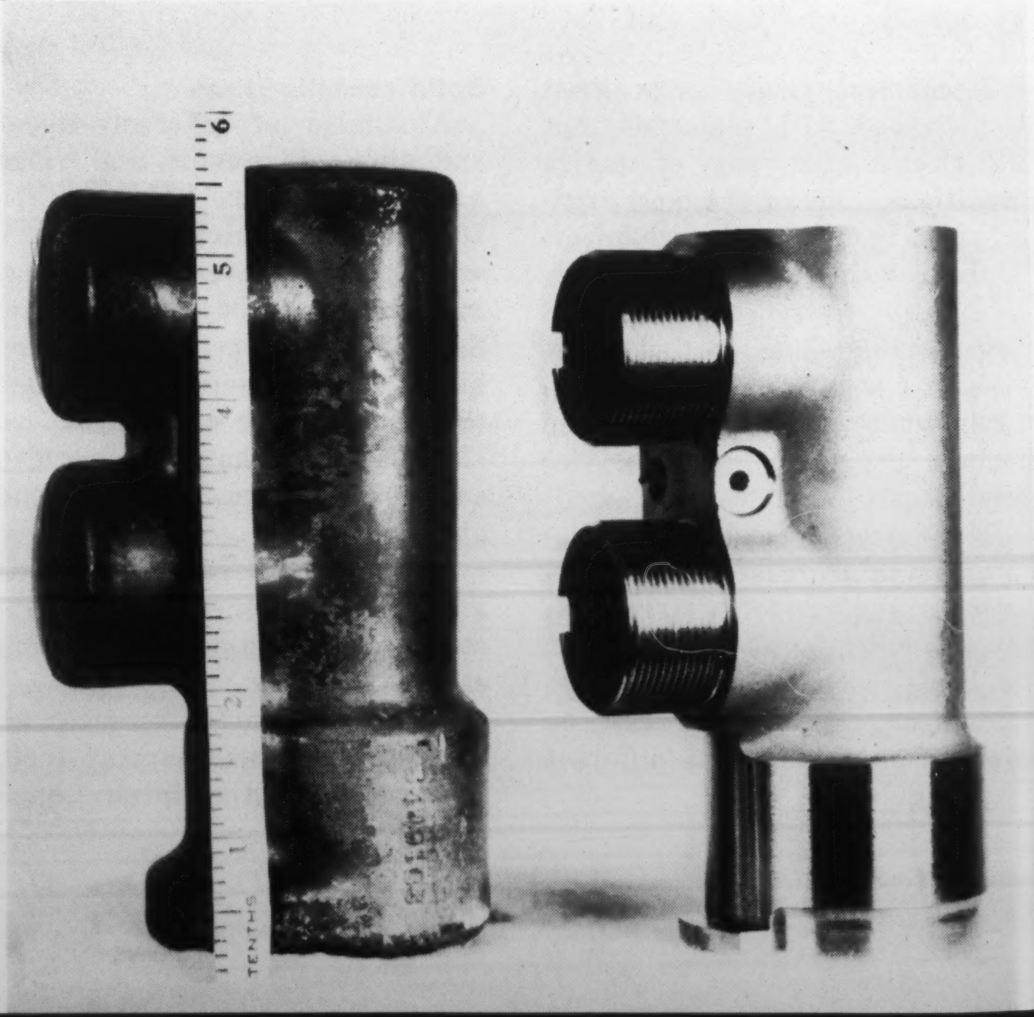
AWARD OF MERIT

EDWARD A. STRATE
Armament Design Engineer,

HARLAN A. REESING
Production Design Engineer,

PERRY D. GOLDBERG
Materials & Process Metallurgist,
El Segundo Div.,
Douglas Aircraft Co., Inc.

Design of breech for aircraft bomb ejector rack using a forged and heat treated titanium alloy to improve performance and reliability.



■ The ejector rack used in high speed military aircraft is a combination of a bomb rack and an ejector which imparts a downward velocity to the bomb or external store in order to get it past the slip stream into undisturbed air.

The ejector consists of three basic parts: breech, cylinder and piston. The breech presented the greatest design problem because of its multitude of functions and irregular shape. Similar breeches made from stainless steel experienced heat checking and failed—generally at the forging flash line—during test firing or hydrostatic testing. Because of the ejector's location on the plane, failure endangers the safety of the airplane and the pilot.

The material

Tests, design calculations and experience indicated that the breech material must have a high strength-to-weight ratio at elevated temperatures for short times, and must have superior corrosion and erosion resistance. Titanium appeared to be the metal most likely to meet these requirements. After tests of available titanium alloys, type 6Al-4V (containing 6 aluminum and 4% vanadium) was selected because it offered:

1. Availability from several titanium producers.
2. Excellent forgeability.
3. Consistent response to heat treatment.
4. Good machinability in the heat treated condition.
5. Low susceptibility to hydrogen embrittlement.
6. Good thermal stability.
7. Microstructure free from longitudinal segregation.
8. Excellent corrosion and erosion resistance.
9. Moderate strength and good ductility after heat treatment.

How breech is made

The breech is produced as an open die forging using a forging temperature of 1720 F. To keep surface contamination at a minimum, the forgings are set on clean fire brick and allowed to cool to room temperature in air.

To eliminate any effects of the forging operations, the parts are annealed at 1300 F for 2 hr, furnace cooled to 1000 F, and then cooled in air to room temperature. The annealed forgings are thoroughly blasted with metal grit to remove oxide scale and the oxygen-rich case resulting from the forging and annealing operations. The clean surface improves the effectiveness of the quench during the subsequent solution heat treatment. Metallic grit blasting also prevents further penetration of the contaminants into the metal.

The forging must be heat treated to attain mechanical properties that will meet the minimum design requirements of 145,000 psi ultimate strength, 135,000 psi yield strength, 12% elongation, and 25% reduction of area. The heat treatment consists of a solution treatment of 1 hr at 1700 F, a water quench, aging for 3 hr at 1000 F, and air cooling to room temperature.

Heat treated breech forgings are again blasted throughly with metal grit. Removal of the scale and the oxygen-rich case not only removes undesirable contaminants but also results in improved machinability with increased cutting tool life. General observations by tool experts and machinists indicate that the forged, heat treated titanium alloy breech has better machinability than a stainless steel breech.

A permanent record of tests to determine the amount of hydrogen absorbed during processing operations is maintained to make certain the total pickup does not exceed a maximum of 125 ppm. A typical record of hydrogen pickup shows:

Hydrogen in bar stock as reported by the mill	31 ppm
Hydrogen content after forging	63 ppm
Hydrogen content of forging after annealing	73 ppm
Hydrogen content of annealed forging after heat treating	75 ppm

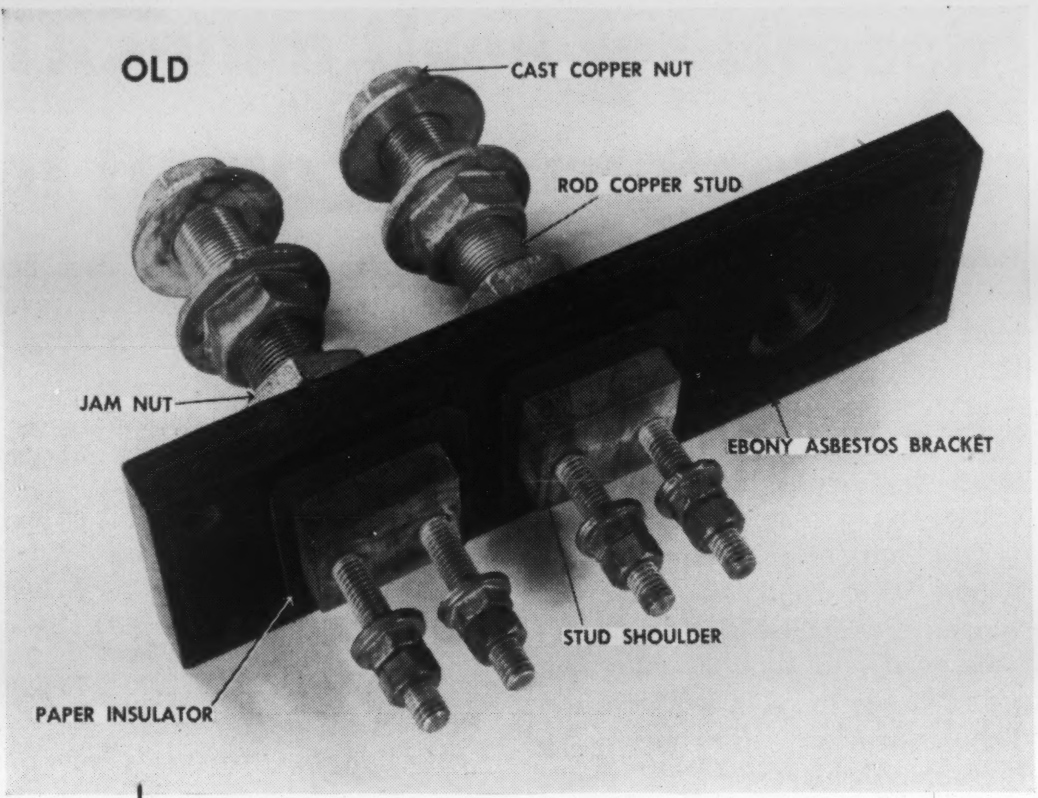
Properties, performance

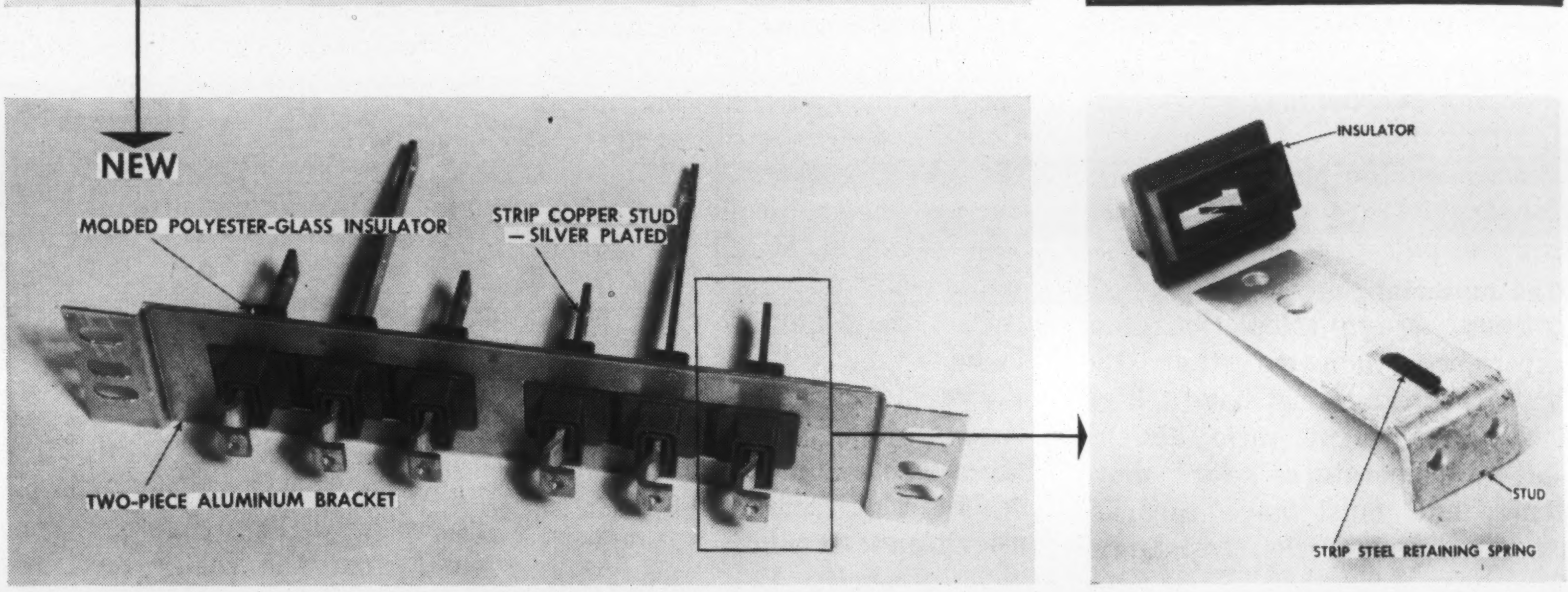
Mechanical properties of the heat treated forging are shown in the accompanying table. The elongation and reduction of area throughout the entire breech did not change after forging and heat treating from the properties of the as-received material. The ultimate strength gain in the outer area resulting from processing is 15,300 psi. Because the center of the breech is machined out, only the outer area conditions are significant in this part. Yield strength gains are 10,300 psi and 2800 psi respectively. These figures for the outer area and center meet the minimum design requirements for the part with sufficient margins of safety to provide for material and processing variations.

The titanium breech withstood 300 firings before showing any evidence of heat checking. There have been no failures in firing, and the titanium breech has been subjected to a maximum hydrostatic presure of 27,000 psi without failure.

AVERAGE MECHANICAL PROPERTIES OF FORGED TITANIUM ALLOY BREECH

Property	Distance from Outer Edge	
	7/16 in.	7/8 in.
Ultimate Strength, psi	159,000	150,500
Yield Strength (0.2% offset), psi	145,000	137,500
Elongation, %	15.0	14.8
Reduction of Area, %	44.0	38.4


OLD
CAST COPPER NUT
ROD COPPER STUD
JAM NUT
EBONY ASBESTOS BRACKET
STUD SHOULDER
PAPER INSULATOR


NEW
MOLDED POLYESTER-GLASS INSULATOR
STRIP COPPER STUD — SILVER PLATED
TWO-PIECE ALUMINUM BRACKET
INSULATOR
STUD
STRIP STEEL RETAINING SPRING

Materials *used in old and new design stud assembly.*

AWARD OF MERIT

W. F. OLASHAW
A. H. ADAMS

Design Engineers,
Distribution Assemblies Dept.,
General Electric Co.

Redesign of back connected stud assembly for a switchboard using new materials to improve performance and reduce cost.

Metal Strips, Plastics Moldings Improve Switchboard Stud Assembly

■ Most large switchboards used to provide centralized switching have traditionally been custom built products. Consequently, the use of high volume, low cost fabricating operations has been limited. Materials have remained unchanged during the years and have not been representative of best functional, cost and fabricating values now available.

In order to correct this condition a design project was established to standardize the various parts used in the structure and bus system of this type of switchboard. The objective was to find one arrangement that would satisfy the majority of requirements. After an evaluation of all the components involved, the back connected stud assembly was selected as a key area where judicious use of materials would result in considerable savings and improved functioning. This assembly ties together the structure, bus system and the disconnect device. It is designed in three basic sizes or ratings: 100, 225 and 600 amp.

New design

In the design of the new back connected stud assembly the major objectives were: 1) lower cost, 2) simplicity of fabrication and assembly, and 3) ability to withstand 50,000-amp short circuit forces.

Mounting bracket — The old mounting bracket was made of 1-in. thick ebony asbestos. The average cost of the material was $2.25 per sq ft, and cost per bracket, including labor, averaged $1.50. The material weighed about 10 lb per sq ft.

To conserve insulating material it was decided to make individual insulators for each stud and to assemble them into a metal mounting bracket. Light gage aluminum sheet was selected for the bracket because it is: 1) capable of supporting all devices involved, 2) nonmagnetic, 3) workable by standard forming, blanking and piercing tools, 4) attractive, requiring no finish, 5) lightweight, and 6) readily available. To simplify assembly of the insulators, the bracket was designed in two parts.

COMPARISON OF INSULATING MATERIALS

Property	Polyester Glass (New)	Ebony Asbestos (Old)
Form	Extruded rod	Sheet
Color	All primary	Black
Water Absorption (24 hr),	0.12	1.0
Density, lb per sq ft in 1-in. thk	8.7	10
Specific Gravity	1.7	2.11
Izod Impact Strength, ft lb/in. notch	4	—
Flexural Strength, psi	13-17,000	5000
Compressive Strength, psi	20,000	11,000
Heat Distortion Temp, F	450	300 max
Tensile Strength, psi	4-7000	3000
Arc Resistance, sec	180	150
Dielectric Strength, v/mil	350	100

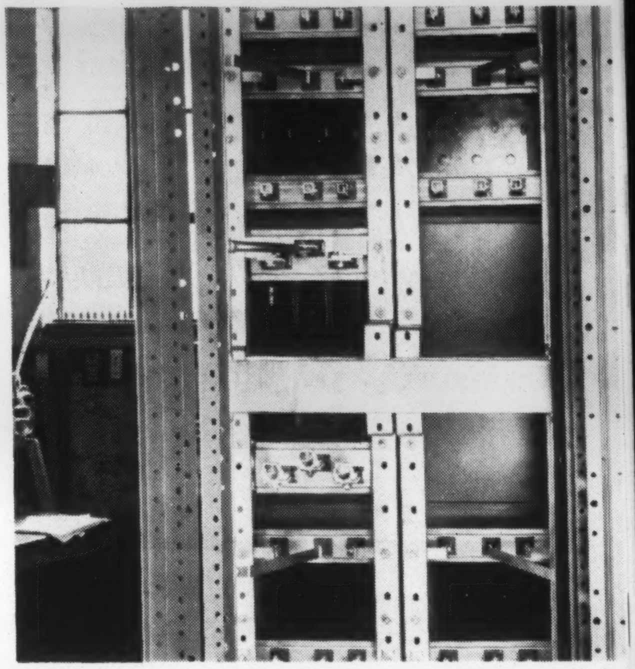
Stud insulators—In the new design the individual stud insulators are one-piece glass fiber-reinforced polyester moldings. This material was selected because of its: 1) high impact strength (Izod of 3-4), 2) arc resistance of 180 sec, 3) resistance to tracking, 4) water absorption rate of less than 1%, 5) availability in several colors, and 6) ability to be molded with conventional tools in large volume. The old design required phenolic tubing or washers as spacers on the stud for insulating purposes. The new design eliminates this component.

Studs—The studs used in the old design were copper rod. Although copper is the best material for this part, the rod form does not lend itself to low cost fabrication methods. Sweating, milling, threading and pinning operations were required to shape the studs. Standard strip copper, a more economical form and adaptable to die working, was selected. The studs are now made in an "L" shape. They are silver plated to prevent joint corrosion.

Retaining springs—To provide automatic locking of the stud in the insulator, a spring-like member was designed to fit on the stud. It consists of a flat strip of spring steel approximately 3/8 in. wide with two lanced ears 1/4 in. apart. The strip is strong enough to act as a locking agent and when heat treated will not set when depressed to 75% of its height.

Advantages

The new design more than meets the stated objectives.



Rear view *of new stud assembly mounted in switchboard.*

1. As shown in the accompanying table, costs were reduced up to 69% and weight lowered by as much as 53%.

2. The studs successfully passed tests in which the stud and device were subjected to the impacts of a 50,000-amp short circuit fault.

3. The excellent electrical characteristics of the glass fiber-reinforced polyester material have greatly increased the safety factor in the switchboard (see table).

4. Additional cost savings are realized by a reduction in shipping weight.

5. The standardization features inherent in this design allow a vertical modular mounting system to be used in the structure. With this system it is now possible to mount devices in any position on all new structures without modification. Also, it is now possible to easily add or change units in the field, an advantage not possible in the custom built type of switchboard.

6. Appearance is greatly improved through use of more colorful materials and the simplicity of the assembly itself.

7. All of the parts are adaptable to volume production methods.

COST AND WEIGHT COMPARISON

Amp Rating	COST			WEIGHT		
	Old, $	New, $	% Reduction	Old, lb	New, lb	% Reduction
100	10.13	3.62	64.4	7	3¼	53.5
225	17.19	5.70	69	8	4¾	41
600	40.90	12.35	66.8	23¼	12	48

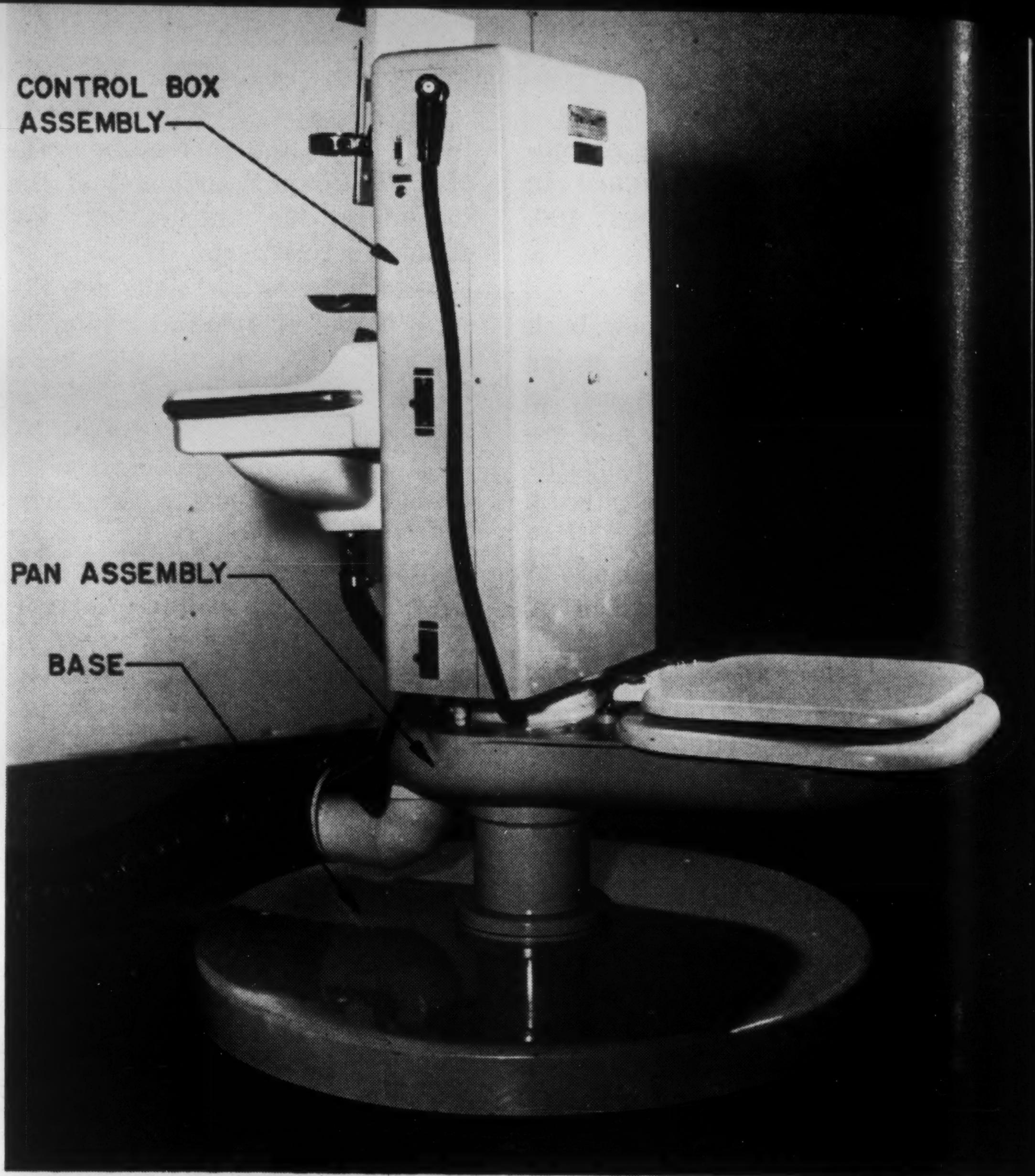
AWARD OF MERIT

R. E. NEARMAN

Project Engineer,

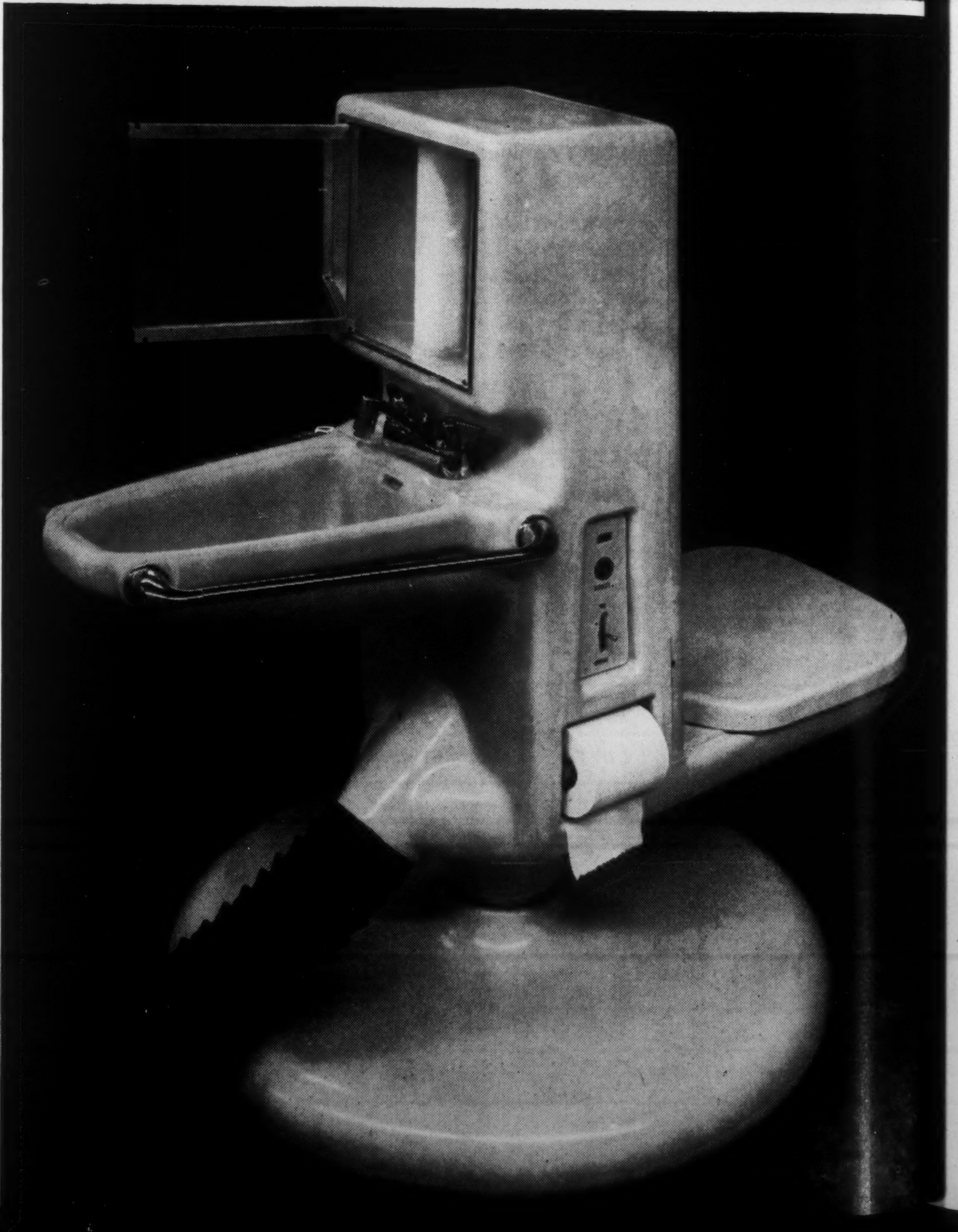
Washington Technological Associates, Inc.

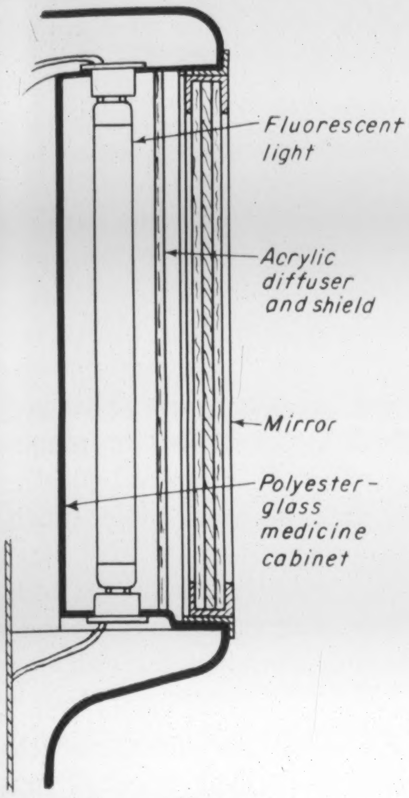
Complete redesign of sanitary fixture replacing the major components with glass fiber-reinforced plastics moldings to simplify fabrication and improve usefulness and appearance.


CONTROL BOX ASSEMBLY
PAN ASSEMBLY
BASE

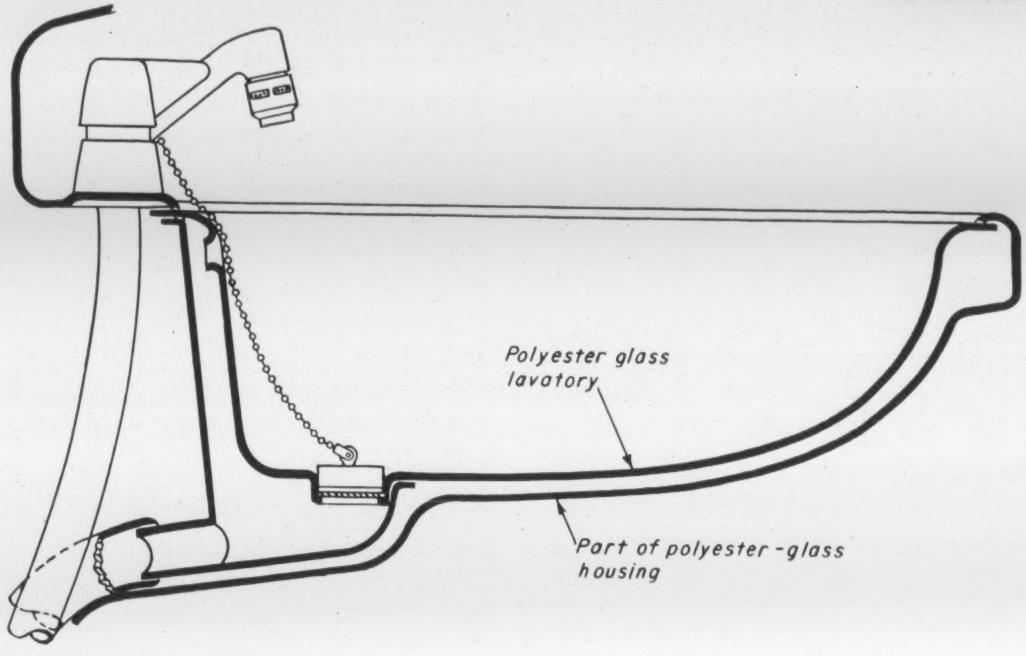
OLD

NEW



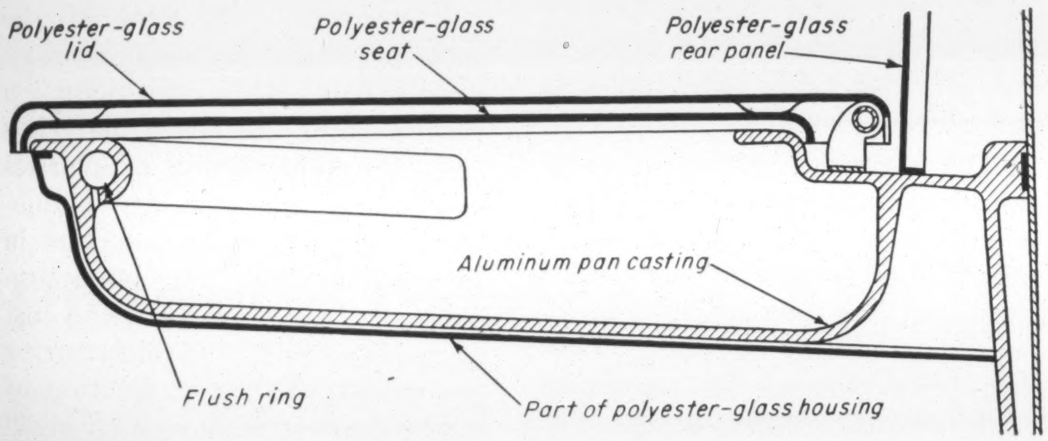

Fluorescent light
Acrylic diffuser and shield
Mirror
Polyester-glass medicine cabinet

Medicine cabinet


Polyester glass lavatory
Part of polyester-glass housing

Lavatory

Detail drawings of redesigned fixture


Polyester-glass lid
Polyester-glass seat
Polyester-glass rear panel
Aluminum pan casting
Flush ring
Part of polyester-glass housing

Toilet bowl

Reinforced Plastics Selected for Mobile Sanitary Fixture

■ The mobile sanitary fixture provides private toilet and lavatory facilities for hospital patients. The fixture has complete sanitary facilities, hot and cold running water, electrical outlets, provision for storing toilet articles, and a mirror with a light for makeup, or shaving. A redesign of the unit was undertaken to obtain a more compact, efficient and attractive product.

Old design

The old fixture consisted of a base, a hydraulically operated elevating assembly, a pan assembly, a control box assembly, and connecting hoses that supplied the electric, water and waste facilities for the unit.

The base plate was fabricated from a flat steel head to which a lightweight, sheet metal strip was tacked. The assembly was painted.

The elevating assembly consisted of a piston assembly operating within a cylinder assembly.

The cylinder was made of a 5-in. dia steel tube. The inside was primed with zinc chromate, and the outer bearing surface was cadmium plated. The piston was a stainless steel tube with a flange welded to the upper end of the tube.

The pan assembly consisted of an aluminum pan casting, a pressed, gray enameled toilet seat and a wood cover. The inside surface and upper edge were buffed to a high gloss, and a black anodized finish applied. The remaining surfaces of the casting had a sand cast finish and were painted.

The control box assembly consisted of a sheet aluminum cabinet that housed a major portion of the water piping and the electrical wiring. A vitreous china lavatory, a mirror and a sheet aluminum light holder assembly were mounted on the outside of the cabinet.

New design

The redesigned fixture is made up of: 1) a base, 2) a housing assembly, and 3) a hydraulically operated elevating assembly. The redesigned unit utilizes the same operating principles and provides the same facilities as the prototype unit. The design, performance, fabrication and appearance have been improved, however, by the use of glass fiber-reinforced polyester plastics for the components described below.

The reinforced plastics components are produced by contact molding, i.e., laying-up on a single mold and molding without pressure. A gel coat layer of polyester resin is applied to the mold to provide the desired color. The color layer is then backed up with resin-impregnated glass mat.

The base consists of a circular plastics shroud that surrounds a six-legged framework fabricated of steel channels.

The housing assembly, the principal component of the new design, is composed of four sections. The body, which is the largest molding, contains the two wells for the plastics lavatory and an aluminum pan casting. The remaining sections include the rear panel, which is a flat sheet, and two control panel sections, one for each side of the housing. The housing is secured to an aluminum channel framework which, in turn, is secured to the pan casting. The entire assembly slips over and rides along a cylinder of the elevating assembly. Two Teflon rings in the pan casting provide the bearing surfaces for the assembly as it moves along the elevating assembly cylinder.

A plastics medicine cabinet is inserted into a cavity near the top of the cabinet on the lavatory side. The cabinet is secured to an aluminum channel framework that is bonded to the housing.

The pan casting for the toilet and the toilet seat and cover of the redesigned unit are similar to those used with the old model. The seat and cover, however, are made of glass fiber-reinforced plastic. Future models will also be provided with toilet pans of reinforced plastic.

The elevating assembly operates much as before but differs slightly in construction. The gland stuffing box of the prototype unit has been replaced by an aluminum casting and the packing has been replaced by an o-ring seal and two Teflon bearings.

Advantages of new design

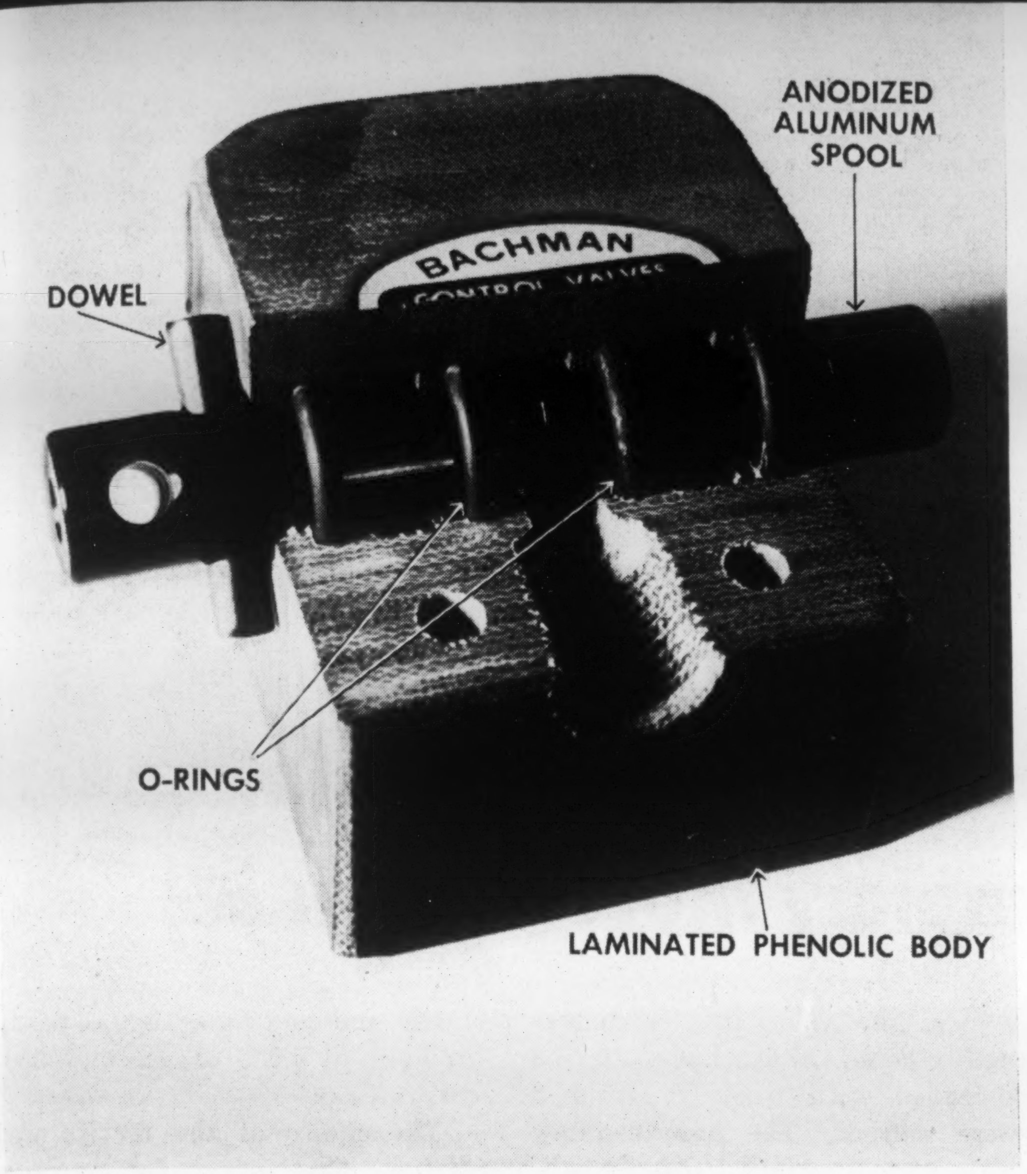
To meet the design objectives, glass fiber-reinforced plastic was selected as the material for the majority of the components. Reinforced plastic is particularly advantageous because it provides greater flexibility in design and greater ease of fabrication than metal, affords a good balance of strength and weight, and is unaffected by most common chemicals to which it may be subjected in hospitals. The specific advantages gained were:

A more useful assembly—The greater design flexibility of reinforced plastics made it possible to mold the housing in such a way that a medicine cabinet, also made of reinforced plastics, could be inserted. This addition provided a new storage area. In addition, the plastics lavatory was not restricted to the shapes of standard vitreous china lavatories. It was therefore designed to extend well over the patient's bed.

Simplified fabrication—The use of reinforced plastics has resulted in simplifying fabrication, particularly of the housing and control box assembly. The plastic can be formed in large sections and with intricate contours. This permits molding recesses for plumbing fixtures. The molded plastics components require little finishing except the removal of a small amount of molding flash. In addition, the color is built-in, thereby eliminating the need for painting.

Weight and cost reduction—The plastics construction of the redesigned unit has resulted in a weight reduction of approximately 60%, enabling patients and hospital personnel to handle the unit more readily. The cost of the unit has been reduced approximately 65%. This cost reduction results from the lower materials cost, the substitution of plastics components for standard plumbing fixtures, and the reduction in fabrication time. For mass production of the new unit, the cost of molds and other manufacturing equipment will be a fraction of the investment necessary for metal fabricating dies and machinery.

Improved appearance—The appearance of the fixture is an important factor in its saleability. The use of reinforced plastics has resulted in a more compact unit with an eye-pleasing appearance. Components, such as soap dishes, the mirror holder and the light, have been recessed into the housing or cast integral with the housing. Plumbing and wiring have been placed within the housing to further enhance appearance. The reinforced plastics components have a finish that is more durable than painted surfaces. The components may be washed with strong solutions commonly used at hospitals without affecting the material or its finish. Periodic repainting will not be required.



Redesigned *control valve.*

CITATION

JOHN D. BACHMAN

President,
John D. Bachman & Co.

Redesign of a low pressure, direct acting control valve using laminated phenolics and anodized aluminum to improve performance and reduce cost.

Phenolic Laminate, Anodized Aluminum Reduce Cost of Control Valve

■ Low pressure, direct acting control valves (1/4 and 1/2 in.) are widely used for controlling operations of diaphragms and cylinders. They are required to operate continuously without service for from 1 to 10 million cycles in air, water, oil or other fluids at pressures up to 200 psi. The materials used in the valves must be wear and shock resistant, chemically inert and unaffected by rapid temperature changes.

Conventional control valves have been constructed entirely of metals. Previous designs of Bachman valves used an aluminum body and a stainless steel spool. The new model is constructed of a laminated phenolic body and an aluminum spool. O-rings are recessed in the valve body, and a simple Rollpin dowel is used for a stop instead of nuts or shoulders.

The laminated phenolic was found to be lighter in weight, superior in shock resistance, and less noisy than the aluminum body. The plastic provides an excellent wearing surface and is unaffected by steam, hot oils, humid atmosphere and many corrosive conditions. The cost of the phenolic laminate itself is equal to that of aluminum, but fabricating cost is considerably less.

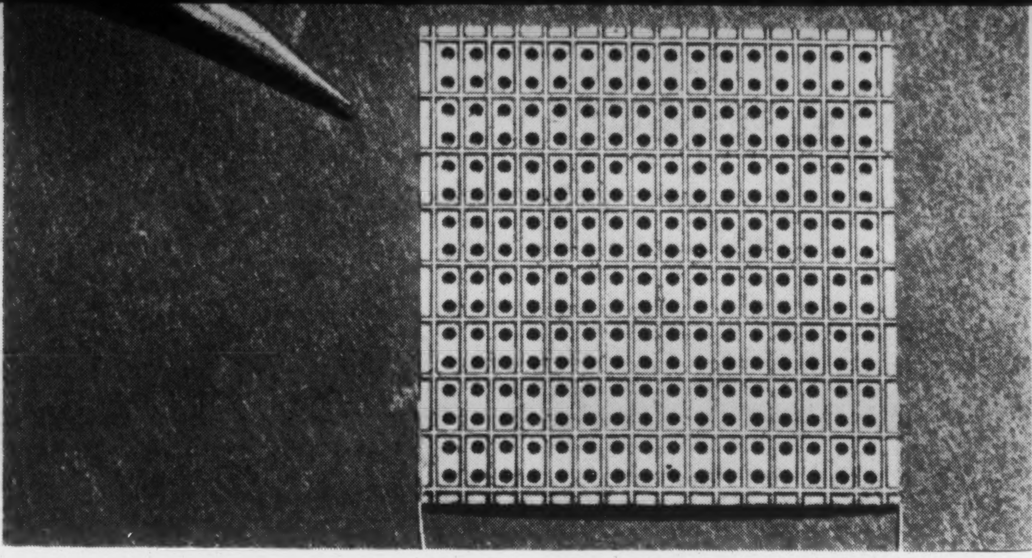
The new aluminum spool is lower in cost than the stainless steel design formerly used. A smooth, wear resistant coating is inexpensively applied to the spool by anodizing.

As a result of the redesign:

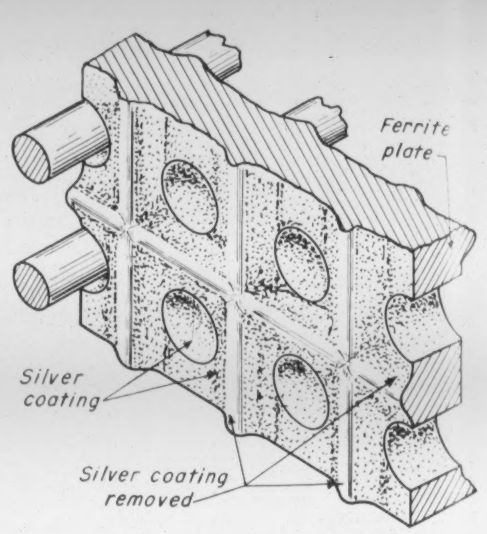
1. Weight has been reduced by about 50% (from about 4.5 lb to 2.5 lb).

2. Cost has been reduced up to as much as 75%. Comparable all-metal valves cost around $45 as compared to about $15 for the new design.

3. The new valves perform satisfactorily for 2 to 6 million cycles — a life that compares favorably with that of the more expensive valves.



Heart *of a new electronic memory system . . .*



. . . and how it is made

Molded Ferrite Memory Plate Makes Computers Simpler, More Compact

■ A key part of all electronic computers is the information storage system in which various elements of a computing problem are stored electronically and recalled instantly as they are needed. The development of this new apertured memory plate is an important advance over the magnetic core system introduced several years ago.

The conventional magnetic core system consists of tiny ferromagnetic cores that have to be threaded with wires to form a wire matrix. The new memory plate was developed from the concept that a large number of discrete magnetic storage cells can be fabricated at once because: 1) it is possible to mold a ferrite plate with an array of holes, and 2) it is possible to apply a conductive metallic layer on the surface of the nonconducting ferrite and through the holes in a geometric pattern such as to provide a "printed winding" linking all holes.

CITATION

JAN A. RAJCHMAN
CHANDLER WENTWORTH

Members of Technical Staff,
RCA Laboratories,
Princeton, N. J.

Development of molded ferrite apertured memory plate with printed winding that opens the way to major advances in speed and efficiency of electronic computers and data processing systems.

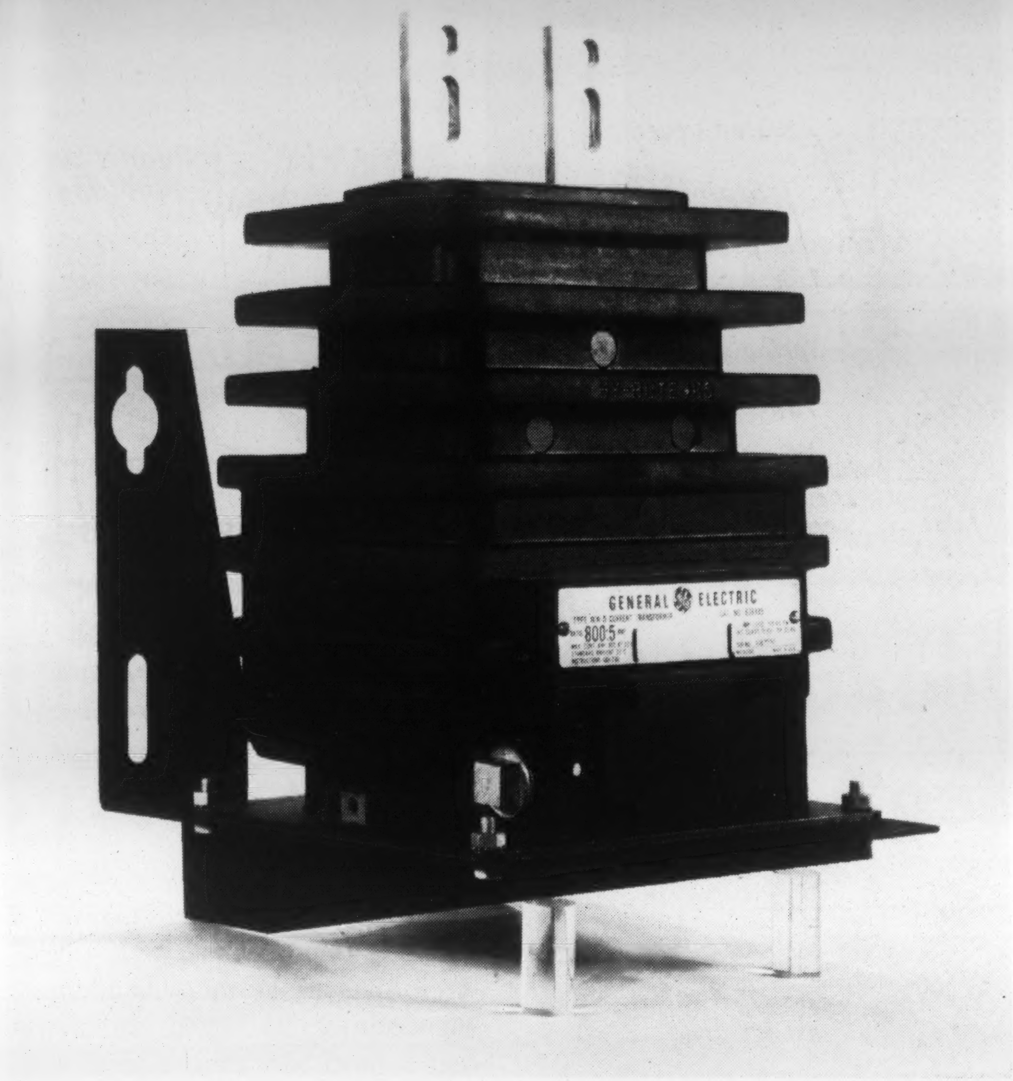
The materials

The basic materials used in the apertured plate are magnesium carbonate, manganese carbonate and ferric oxide. After the plates are pressed and fired, they are coated over completely, including the inside walls of the holes, with chemically deposited silver. The removal of silver from previously molded ridges in an appropriate pattern leaves the silver in a form of a winding that links all holes. Leads are attached to the plate by silver paste. Finally the silver winding is plated with copper to increase the conductivity to the desired value. The plates that have been molded in quantity are about ⅞ x ⅞ in., are 0.026 mils thick, and contain a 16 x 16 array of holes of 0.025 in. dia on 0.050-mil centers.

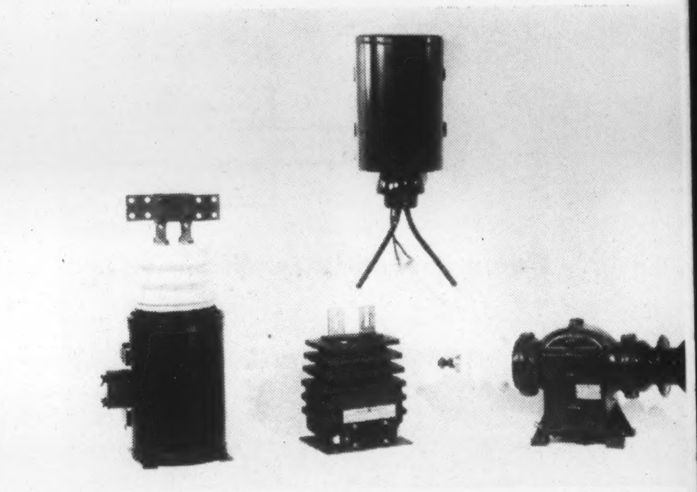
The choice of the ferrite was dictated by the need for a square hysteresis loop for the proper operation of the memory. The choice of silver for the base material of the printed winding was determined by the ease and thoroughness of chemical deposition. The choice of copper as the material plated on top of the chemically deposited silver was determined by the desire to reduce the electrical resistance of the winding as much as possible and by the thoroughness with which it adheres to that kind of silver deposit.

Advantages

Advantages of the ferrite apertured memory plate are many. For an equivalent number of storage bits of information, it is possible to make and test the plates with much less labor and cost than is required using individual magnetic cores. The new memory plates provide the means for handling millions, rather than hundreds of thousands, of bits of information. At the same time they offer far greater compactness and operating simplicity than could be achieved with the earlier memory system.



Rubber-encapsulated transformer *(left) replaces several old designs shown below in smaller scale (note new design in center).*



Outdoor Transformer Embedded in Butyl Rubber

■ The newly developed out-of-doors high voltage instrument transformer is an outstanding example of how an improved material, especially engineered for the application, was the basis for a major and comprehensive product improvement. The material permitted a basically different method of construction for a type of product that had seen little previous change in half a century.

The significant feature of this construction is that the entire transformer is embedded in butyl rubber through a pressure molding process. During molding, the butyl flows between core and windings to provide the basic insulation of the transformer, at the same time forming the external case and insulator skirts as a single, homogeneous piece of material.

The new design provides important advantages to both customer and manufacturer through improved performance, reduced maintenance, more rugged construction, better appearance, reduced size and weight, greater standardization, and opportunity for more highly mechanized manufacture with a resulting increase in product uniformity.

All of these advantages spring directly from the use of one material—a special formulation of butyl rubber that will not carbonize when exposed to electric arcing across its surface. This nontracking characteristic makes it feasible, for the first time, to produce a high voltage outdoor transformer by molding it in an insulating compound as a single unit rather than building it up of separate assemblies of transformer, metal case and porcelain insulators.

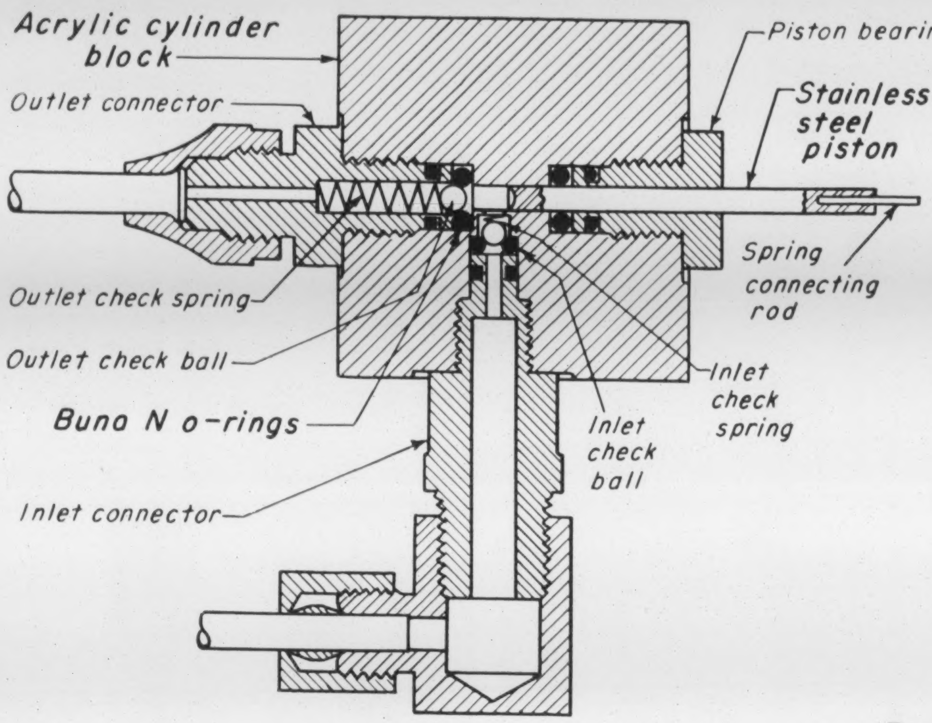
For further details on the subject of this entry, see MATERIALS & METHODS, Nov '55, pages 149-150.

CITATION

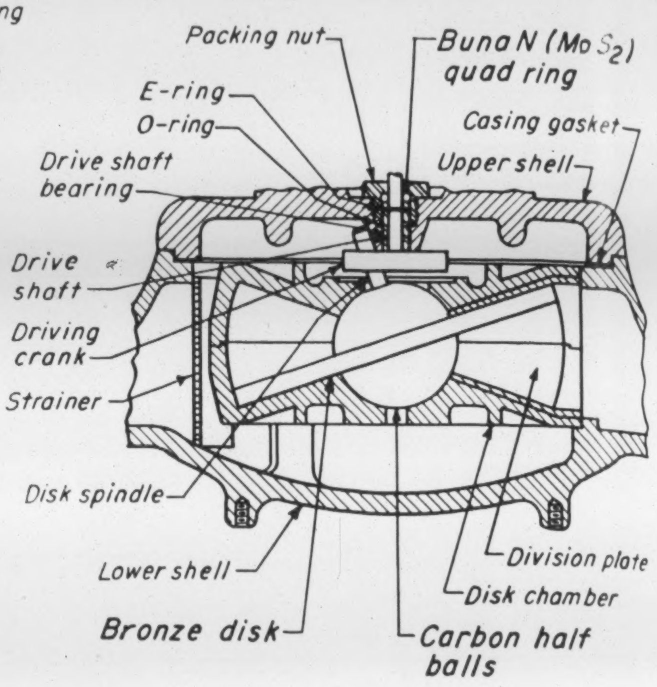
ENGINEERING SECTION

Instrument Dept.,
General Electric Co.

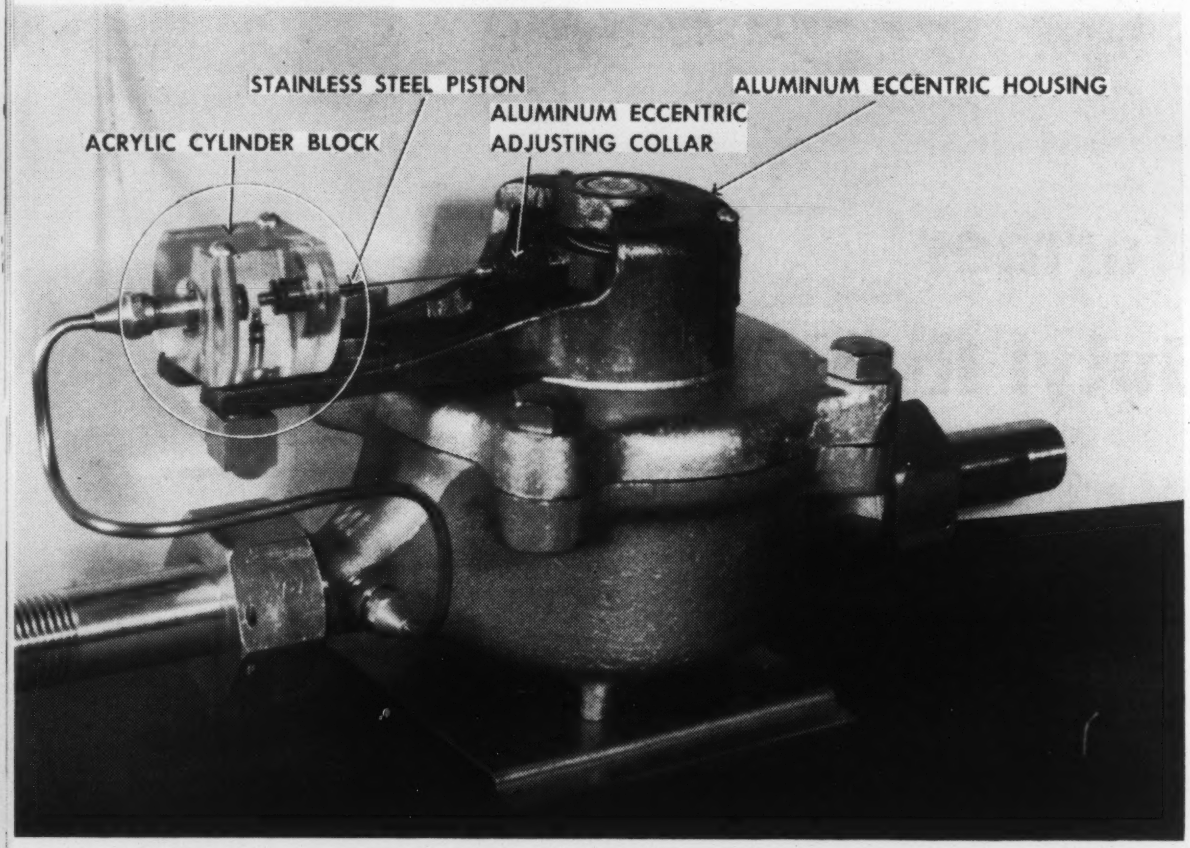
A completely new design of an out-of-doors high voltage instrument transformer which embeds the entire unit in a specially developed nontracking butyl rubber.


Acrylic cylinder block
Outlet connector
Piston bearing
Stainless steel piston
Spring connecting rod
Outlet check spring
Outlet check ball
Buna N o-rings
Inlet check spring
Inlet check ball
Inlet connector

Pump assembly *(circled below).*


Packing nut
Buna N (MoS_2) quad ring
E-ring
O-ring
Casing gasket
Drive shaft bearing
Upper shell
Drive shaft
Driving crank
Strainer
Disk spindle
Lower shell
Division plate
Disk chamber
Bronze disk
Carbon half balls

Power section.


STAINLESS STEEL PISTON
ALUMINUM ECCENTRIC HOUSING
ALUMINUM ECCENTRIC ADJUSTING COLLAR
ACRYLIC CYLINDER BLOCK

CITATION

CARL A. MILLER

Physicist,

Economics Laboratory, Inc.

Sound selection and use of materials in design of a new rinse injector device for a commercial dishwasher.

Rinse Injector Unit Withstands Severe Corrosive Conditions

■ The selection of materials for the rinse injector unit posed a number of problems. One of the most important of these was to select materials that would operate satisfactorily in contact with the corrosive rinse compound. Another was to choose materials for the power section that would perform in hot water (up to 210 F).

The materials selected for some of the principal components are given below:

Cylinder block—Methyl methacrylate plastic satisfied the requirements for corrosion resistance, light weight, good appearance and ease of machining to close tolerances. Its transparency also enables a salesman to show a prospective customer the pump in operation.

Pump o-rings, rotary seal—A

Buna N compound found to be resistant to attack by the rinse compound was selected for the o-rings. A quad ring of Buna N with molybdenum disulfide added is used as a rotary seal on the drive shaft. The molybdenum disulfide acts as a lubricant for the shaft in hot water. This seal has been found to give long life without leakage.

Piston — Stainless steel type 316, centerless ground to a 6-microinch finish gives long life to the pump o-rings and the piston.

Power section—Carbon, bronze and several types of hard rubber were tried. Carbon half balls with a bronze disk were chosen on the basis of satisfactory life and cost.

Adjusting collar, ring, eccentric housing — Aluminum was chosen on the basis of weight, cost and appearance. The eccentric housing and collar are anodized green, and the ring is anodized red for contrast.

Glass Linings for Smokestacks Prolong Life, Reduce Cost

■ The rapid corrosion of unlined carbon steel smokestacks and the frequent interior maintenance required on brick or gunned-concrete lined stacks has been a persistent and costly problem in industry for many years. To solve this corrosion problem and eliminate other disadvantages of conventional stacks, A. O. Smith developed a new smokestack that takes advantage of the excellent corrosion resistance of glass.

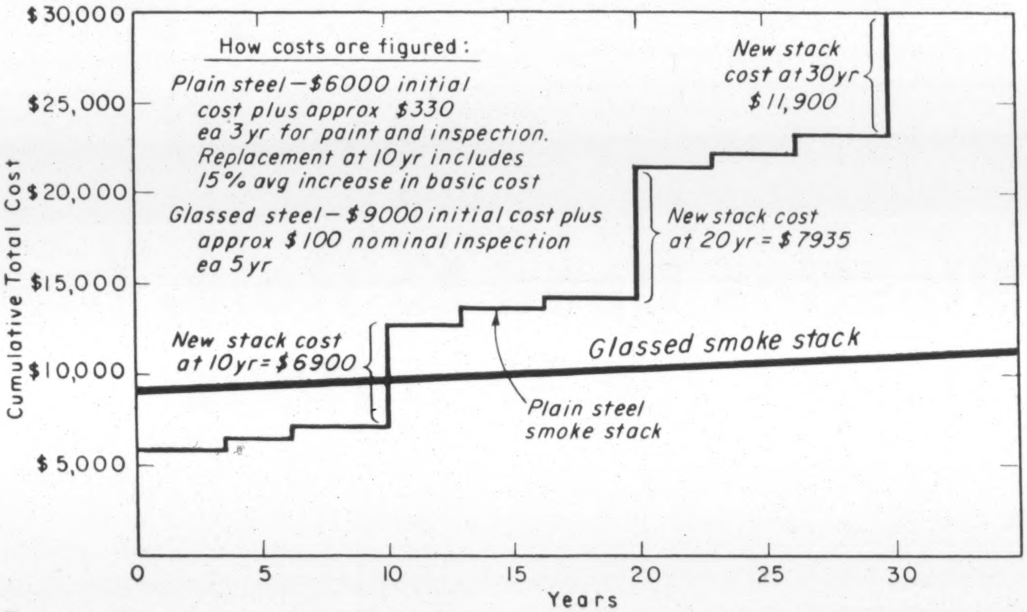
The new stacks are produced in sections up to 20 ft long and up to 8 ft in dia. The structural material is ¼-in. steel (ASTM A 285, Grade A or equivalent). The coating is a specially formulated acid resistant glass. It is sprayed on the outside and inside of the stack. After drying, it is fused to the steel at 1650 F in a specially designed furnace. The glass coating has a coefficient of thermal expansion compatible with that of steel. It also has sufficient elasticity to bend with the steel without failure. For example, an 8-ft dia section can be compressed to 6 ft, 8 in. in dia without damage to the glass coating.

CITATION

RESEARCH & DEVELOPMENT DIV.

A. O. Smith Corp.

Use of glass-coated steel in the construction of industrial smokestacks to provide significantly longer life and greatly reduced maintenance costs.



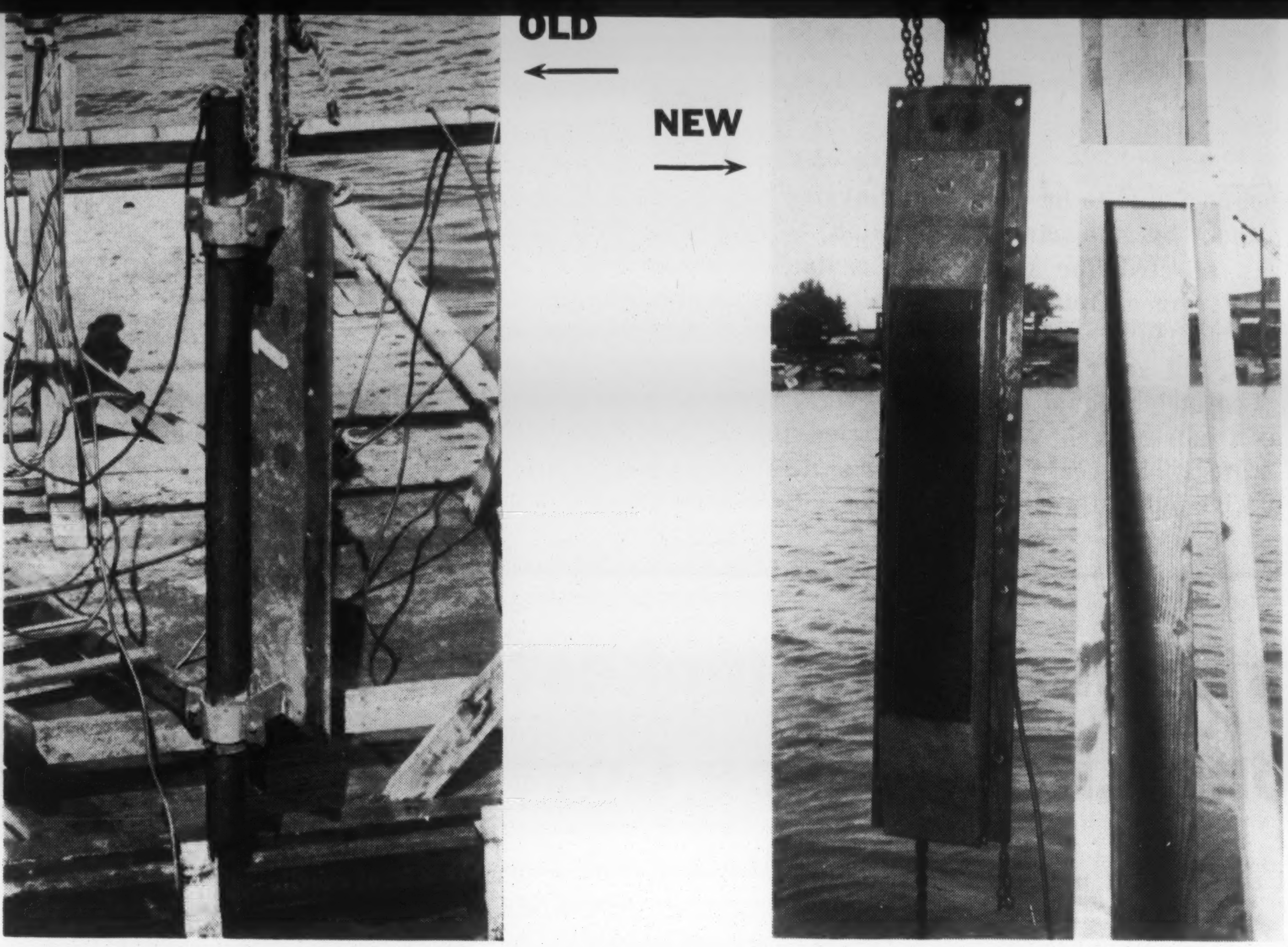
Economics *of glassed smokestacks.*

Tests have shown that glass coated steel smokestacks will have life spans of more than three to five times those of plain steel stacks in similar service. The acid resistant glass successfully withstands the attack of sulfurous compounds encountered in flue gases and is satisfactory for continuous exposure at temperatures up to 750 F.

The initial cost of a glass lined stack is higher (by about 50%) than that of the plain steel type. However, when the maintenance and replacement costs of a plain steel stack are added to its initial cost, the cost of a glass lined stack proves to be significantly lower.

The glass coating weighs about 5 oz per sq ft (inside and out) as compared to up to 50 lb per sq ft for coatings used on brick or concrete stacks. Because of the relatively light weight of steel stacks, foundation costs for a glass coated steel stack are considerably lower than for any other type of lined stack.

This development has been covered previously in MATERIALS & METHODS (Sept '56, p 99).



Plastics Used to Hold, Insulate Anodes for Ship Hulls

CITATION

F. E. COOK

Materials Engineer,

H. S. PREISER

Corrosion Engineer,
Bureau of Ships, Navy Dept.

Design of an improved and less expensive holder for graphite anodes used in cathodic protection of ship hulls.

■ One of the principal requirements of anode holders used in the inert energized anode system of cathodic protection is that the graphite anode be electrically insulated from the object to be protected. In the design of a holder for naval use, other important requirements must be met. Specifically, the holder must: 1) provide a shock resistant mounting for the anode, 2) be streamlined to reduce turbulence, and 3) be resistant to sea water and to anodic reaction products.

Old design

One of the first graphite anodes used in the cathodic protection of an active ship operating in sea water was an adaptation of the anode commonly used on underground structures. It is a single 3 x 60-in. anode supported and electrically isolated at each end by rubber gaskets inserted into steel ring clamps. These clamps were welded to the hull of the ship at selected locations and were painted.

A commercial design used on a ship operating in river water was also tested. It consists of a rectangular graphite slab in a painted steel box with one face open; the anode is insulated from the box with Teflon sheet. The box was fastened to the hull by welding.

These holders failed to meet the service requirements. Short circuits occurred between anode and holder and between holder and hull. Isolated metal in the holders was consumed by stray current. The holders were not streamlined, and the commercial design was costly and too heavy.

New design

The new design consists of a graphite bar (3 x 8 x 36 in.) of trapezoidal cross section encased or cast in a glass fiber-reinforced polyester resin holder. One surface of the graphite extends slightly above the sides of the holder. The plastics holder is streamlined in shape and extends beyond the graphite on the ends. The holder is attached to the hull by means of studs welded to the hull which pass through holes in the plastics ends. The nuts, which are countersunk in the holder, are covered with plastics plugs. The sides of the graphite are roughened so that the resin can achieve a strong bond. An epoxy resin coating is applied over the polyester on the bottom surface of the holder.

The main advantage of the new design is that the entire holder is a dielectric and, therefore, cannot cause a short circuit with the hull. Other important advantages of the new design:

1. No disintegration of the holder occurs due to anodic or cathodic reaction or to immersion in sea water.

2. The plastics holder can be designed to have adequate strength and impact resistance to protect the graphite anode.

3. A streamlined anode holder is fabricated more readily in plastics than in other materials.

4. Studs and nuts used for attachment can be readily covered by plastics plugs of the same material as the holder.

5. The epoxy resin coating on the bottom surface of the holder, though it does not resist the anodic reaction products, does provide resistance to the highly alkaline cathodic reaction products. (Conversely, the polyester resin is resistant to the anodic reaction products but not to the cathodic reaction products.)

6. The plastics holder costs less for equal life. The unit price of the redesign is $200 as compared to $500 for the comparable previous commercial design.

7. The new holder weighs two-thirds less than the commercial design.

Materials for Test Chamber Selected in Extensive Study

■ The Reliability Test Section of Inland Testing Laboratories was assigned a program of testing over 70,000 electronic components under simulated environmental and load cycling conditions. To conduct a reliable test program, it was important that the frames, mounting boards and cabled leads used in the test chambers not affect the test results. For this reason, the design and fabrication of these units had to be carefully engineered, and final choice of materials was made only after evaluation studies of many available materials. The winning entry describes in detail the evaluation program conducted to select the materials that would best withstand the varied conditions within the test chamber without affecting the test specimens.

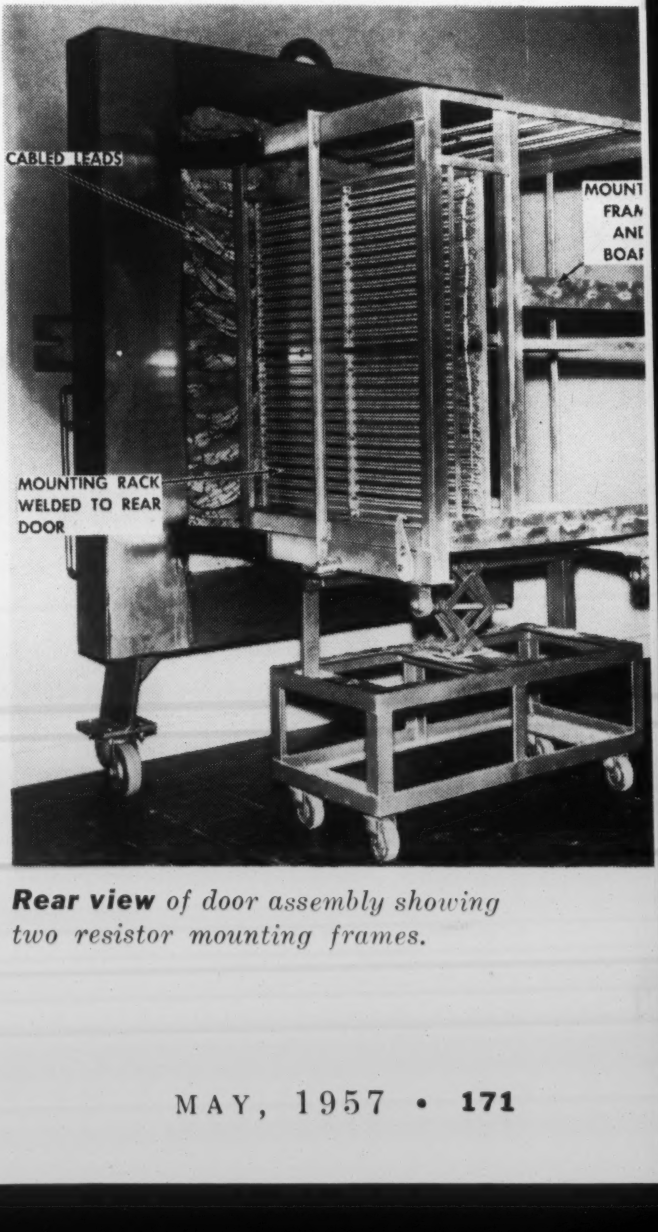
The materials, selected on the basis of insulation and strength tests at high and low temperatures (from −85 to 212 F) and under high humidity (up to 100%), were: phosphate coated (Alodized) aluminum for the frames and mounting boards; electrotinned brass for the standoff terminals; Teflon for inserts for the standoff insulators; and wax-impregnated nylon for the lacing cord and straps.

CITATION

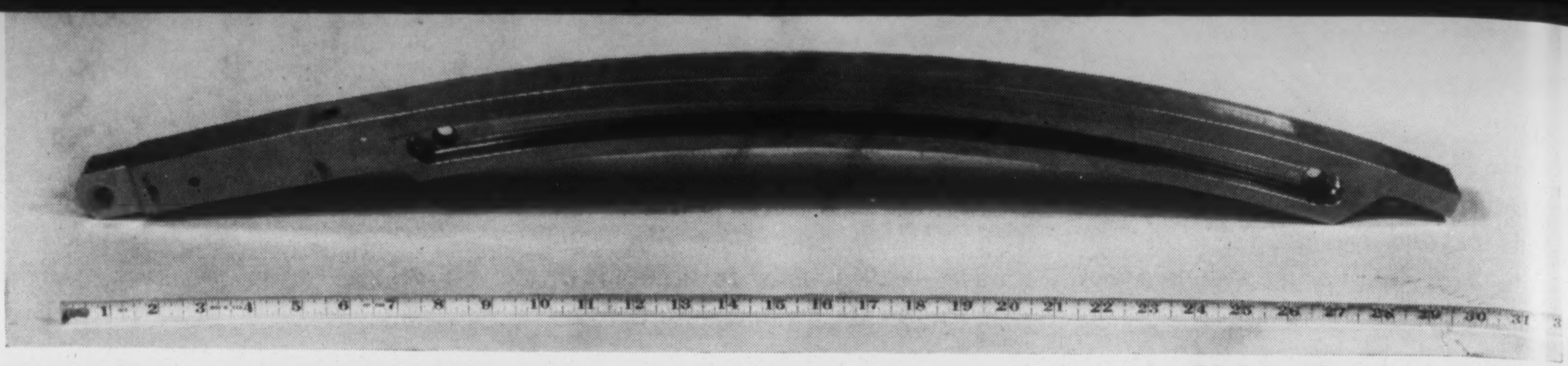
CURTIS MORLING
and
JOHN BELLINGER
Project Engineers
Inland Testing Laboratories
Div., Cook Electric Co.

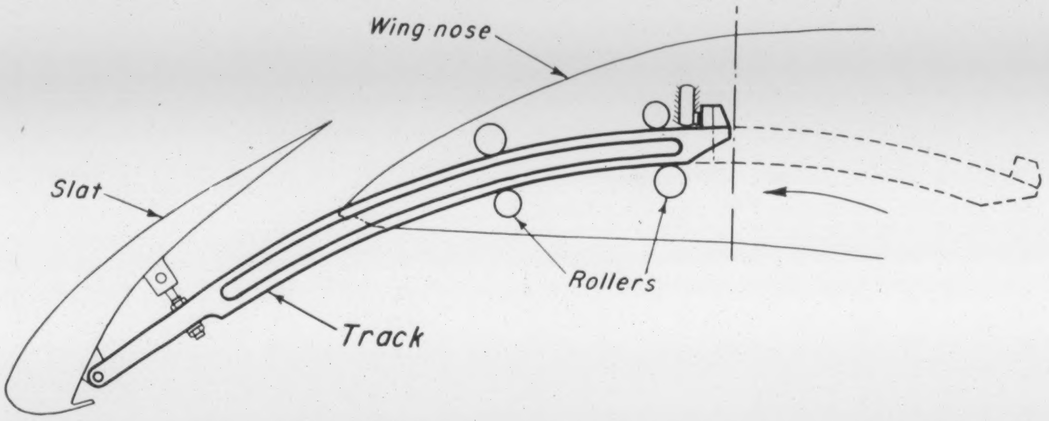
A comprehensive and thorough program to select the best materials for frames, boards and cabled leads used in environmental test chambers for testing electronic components.

This entry will be published in full in a future issue.



Rear view *of door assembly showing two resistor mounting frames.*





Slat track *and how it works.*

Titanium Used in Jet Slat Track to Reduce Weight, Inertia

■ Confronted with the problems of excess weight, high inertia forces, corrosion and compass deflection, Douglas engineers designed the Navy A3D Skywarrior slat tracks using heat treated titanium. Static and fatigue tests have since indicated that this application of titanium has important over-all advantages that warrant its use on current and future designs.

CITATION

HARLAN A. REESING
Production Design Engineer,

JAMES G. QUINN
Design Specialist—Structures,

PERRY D. GOLDBERG
Materials & Process Metallurgist, El Segundo Div., Douglas Aircraft Co., Inc

Design of slat track for military jet airplane using a heat treated titanium alloy to reduce weight and improve service performance.

The slat track supports and operates a movable surface (slat) on the leading edge of the wing of an airplane. During certain maneuvers the slats open rapidly and suddenly stop when they reach the full open position. The inertia forces result in high stresses on the slats and the track.

The principal objective in designing the slat track was reduction in weight to improve performance of the aircraft in general and to reduce the inertia force of the slat. Furthermore, as steel tracks were having a decided effect on the magnetic compass, a nonmagnetic material was desired.

DESIGN REQUIREMENTS AND PROPERTIES OF 6AL-4V TITANIUM

Property	Douglas Min Design Requirements	Average Test Results (formed and heat treated)
Ultimate Strength, psi	150,000	150-159,000
Yield Strength (0.2% Offset), psi	135,000	136-146,000
Elongation (in 4D), %	8	13
Reduction of Area, %	20	40-43
Rockwell C Hardness (max)	42	—

The material

The magnetic handicap of 4130 (tube and bar), stainless steel and AMS 6418 (Hy-Tuf) bar eliminated them from consideration. Also, the necessity for chromium plating was a disadvantage of all but stainless steel. Monel K bar could pass the test, but its weight is approximately twice that of titanium.

Evaluation of available titanium alloys indicated the 6Al-4V alloy (containing 6 aluminum, 4% vanadium) was most suitable for this application. Among the primary reasons for the selection of this alloy were its availability from several producers and its consistent response to heat treatment. Also, the alloy has low susceptibility to hydrogen embrittlement. Other advantages are its good machinability in the heat treated condition, superior corrosion resistance, satisfactory formability, high strength-to-weight ratio, relative lack of notch sensitivity at moderate strength levels, and good resistance to creep and fatigue.

Performance

The heat treated titanium alloy

more than met all design and service requirements. The accompanying table shows the design strength requirements and the average test results on the heat treated and formed 6Al-4V alloy. Repeated impact loads against the stop (20,000 cycles) did not develop any cracks or failures in the titanium track or in the seration under the stop. The test track was statically tested and put through design loads without failure. Brinelling of roller on track under load was negligible.

As a result of the new design, weight savings of 44% were obtained. This weight saving is valued at $50 per lb. Plating problems encountered with steel tracks were eliminated. The nonmagnetic properties of titanium also proved to be a distinct advantage and greatly minimized the problem of compass deviation.

Toxic Fume Exhaust System Uses Metals, Plastics and Ceramics

■ The basic design of fume exhaust systems is relatively straightforward, for it involves largely the application of fundamental formulas and knowledge. The major and critical problem is to select the proper materials and arrange them efficiently and economically to perform satisfactorily at high temperatures in the presence of extremely corrosive conditions.

This winning entry describes how the materials were selected for a new toxic fume exhaust system designed for a precious metal plant. The system consists of a scrubbing unit, a spray system, a condensing unit and ductwork.

The old installation was constructed almost entirely of ceramic materials. The new system was required to handle twice the volume of fumes using a minimum of additional plant space. The design objectives were achieved by selecting materials for each part of the system that would most efficiently meet the service requirements. Materials used include rigid polyvinyl chloride, Teflon, ceramics, chlorosulfonated polyethylene, steel and glass.

This entry will be published in full in next month's issue.

CITATION

JOSEPH H. GETTIG

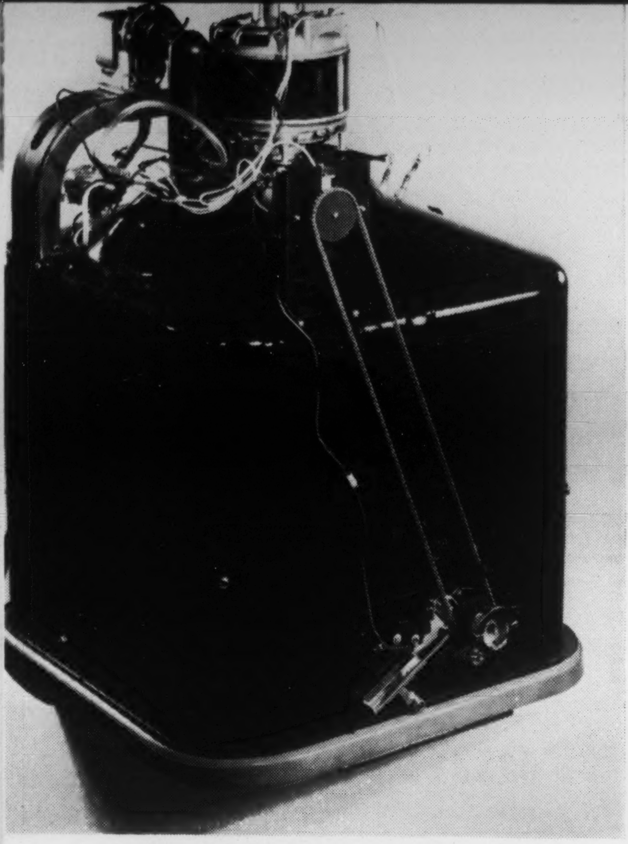
President,

Gettig Engineering & Mfg. Co.

Spring Mills, Pa.

Imaginative and efficient use of many different engineering materials in the design of a toxic fume exhaust system.

Packing *used to seal glass tubes in headers is chlorosulfonated polyethylene —one of many different materials used in a new fume exhaust system.*



Inner tub . . .

. . . eliminated in new design →

Plastisol Coating Eliminates Inner Tub of Dishwasher

■ The principal objective in designing the 1957 portable dishwasher was to devise a means of using single wall construction and thereby reduce manufacturing costs by 10 to 15%.

CITATION

M. R. KAUFFMAN

Dishwasher Project Engineer

Dishwasher and Disposal Dept.,

General Electric Co.

Redesign of portable dishwasher in which use of a plastisol coating has made possible single-wall construction.

The old model was a two-assembly structure consisting of a tub and outer cabinet. The exterior and interior of the tub were porcelain enameled. Rack supports and other brackets were fastened to the tub by means of through holes, screws and rubber washers. These holes, of course, were potential water leaks, and the screw heads and washers were possible lodging places for bacteria.

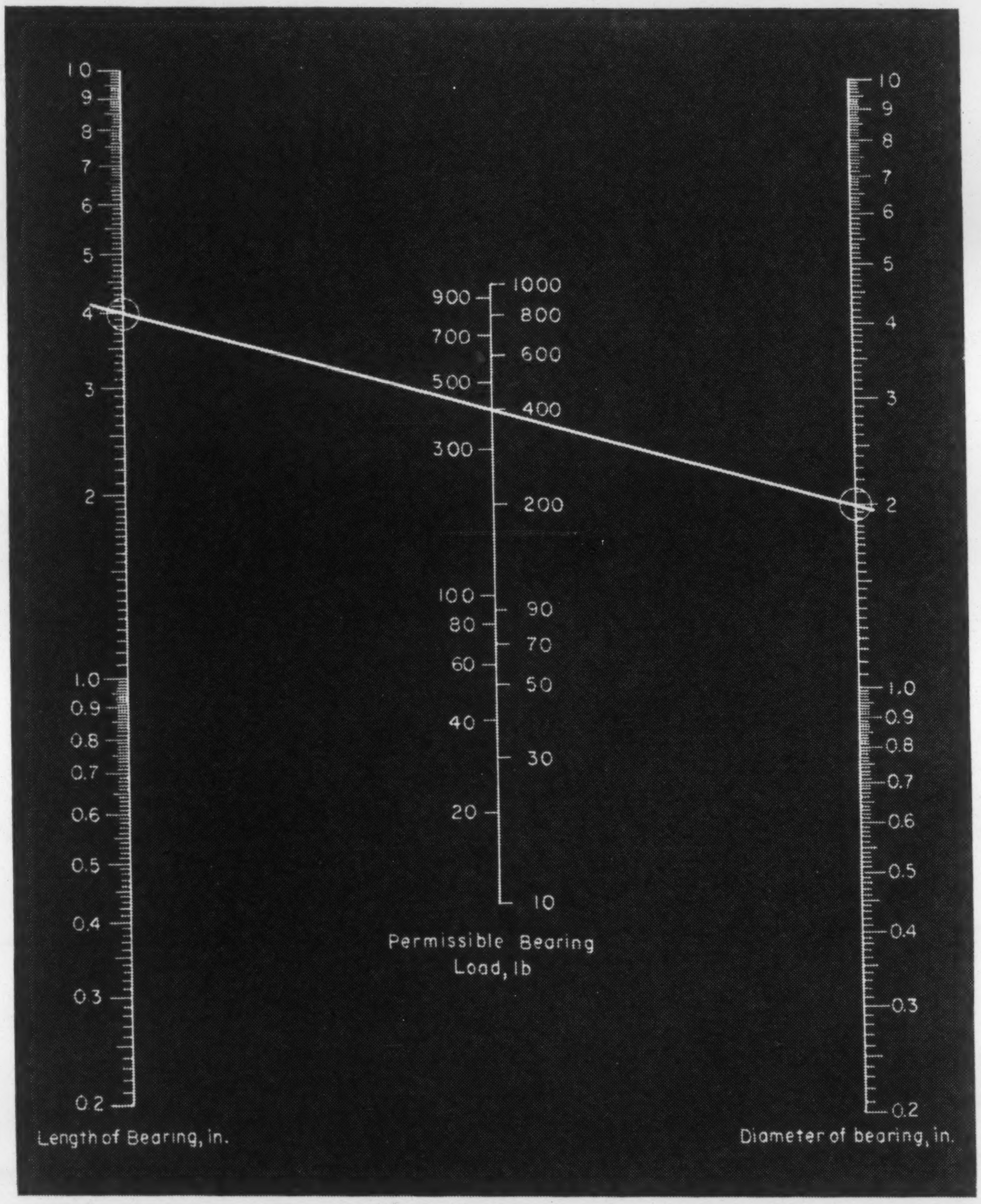
The new 1957 portable dishwasher structure consists of one major tub assembly. A single sheet of 0.048-in. sheet steel is welded and expanded to a rigid cylinder. A drawn bottom of 0.048-in. sheet steel with a motor mounting flange is attached to its underside by a punch pressed seam. The entire interior of the structure is sprayed with a polyvinyl chloride plastisol coating. This coating forms a continuous surface of unbroken film from the top lip of the tub over the entire portion of the washing compartment, including the rack supports and the bottom flange. The heavy coat of plastisol bridges the gaps between the spot welds and protects the seam at the bottom flange. The exterior of the tub is covered with a conventional coating of baking enamel.

Through use of the sprayed plastisol coating, single wall construction was made possible. The amount of steel per unit has been reduced from 55 to 48 lb. Manufacturing costs can be cut 10%. The plastisol coating also serves as a cushion for the dishes, it does not chip, and its continuity eliminates the unsanitary indentations of the previous design.

A limited number of reprints of this report are available at 50¢ each.

Nomographs for Carbon Bearing Design

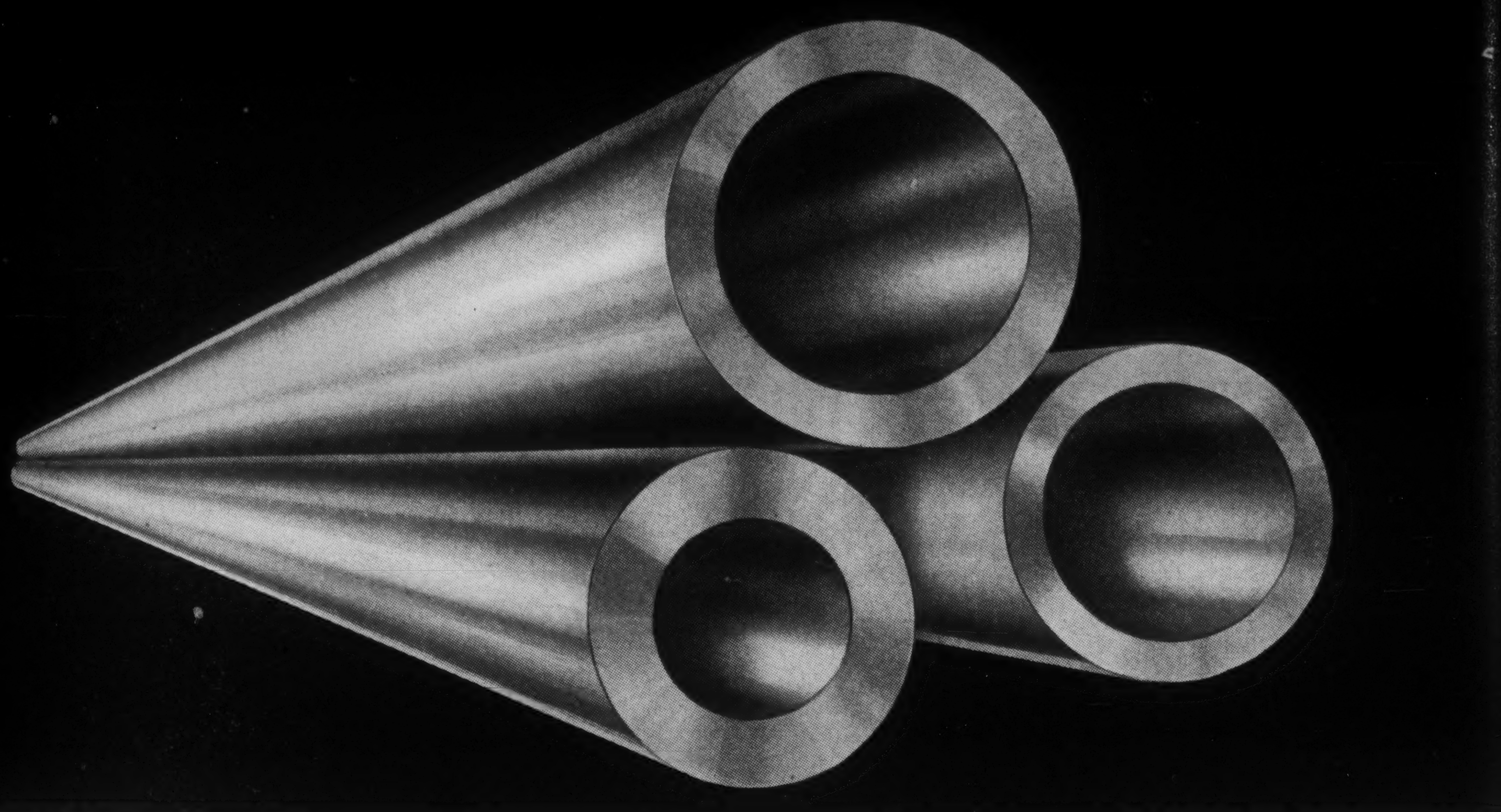
50 psi Unit Loading

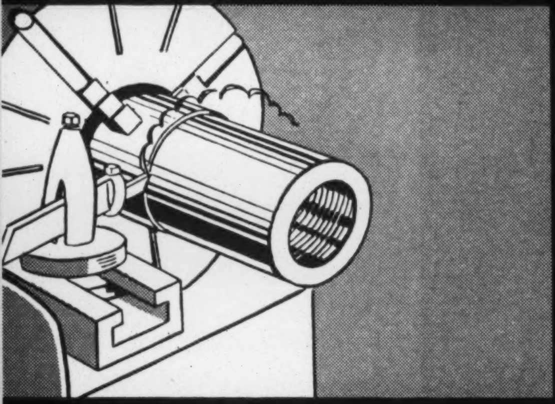


In designing any carbon bearing surface for dry operation two primary factors that influence service life must be considered: 1) unit loading of projected area should be 50 psi or less, and 2) the PV (unit loading in psi x surface speed in sfm) should be 12,000 or less for dry operation.

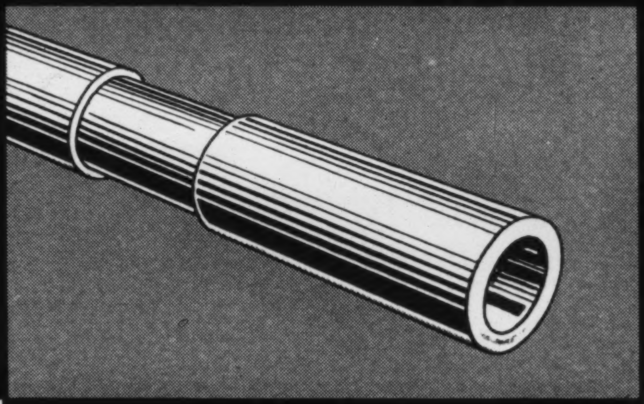
Nomographs on these two pages present a simplified method of checking carbon bearing design, both for possible use of carbon to replace other materials, and for designing new bearings. The values given are ideal and may be exceeded in many cases. A sample problem on the next page shows how to use the graphs.

◄ For more information, Circle No. 600

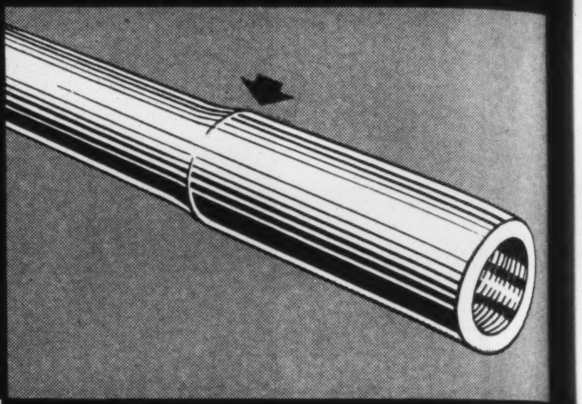




Worn drill collars are "peeled down" for perfect roundness, eliminating surface scars and imperfections.



Tubing sleeve is shrunk into perfect position.



Sleeves are securely welded. Thus drill collars go back into service actually as good as new.

MATCHING TUBES TO JOBS

Drill collars and tool joints can't last forever in oil well equipment service. Abrasive wear reduces the strength and the safe minimum O.D., and makes the bearing faces eccentric. When so worn, they are repaired by using sleeves—as shown above. One producer of such equipment brought a problem to B&W—"How could this 'sleeve' job be done with a minimum cost in equipment, operations, material and time?"

Because of the diversity of its types of tubular products and experience in matching tubes to jobs B&W was able to supply tubing in the proper type, size and grade and with appropriate tolerances and physical properties. This, in turn, reduced the number of fabricating operations and eliminated excessive machining and the need of some fabricating equipment. This manufacturer was able to "repair and place in as good as new condition" these rather expensive products—and at a substantial reduction in cost.

Friendly Mr. Tubes—your link to B&W—is the man to call when tubing can save the day in your own operation. His business is matching tubes to jobs—jobs like yours. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

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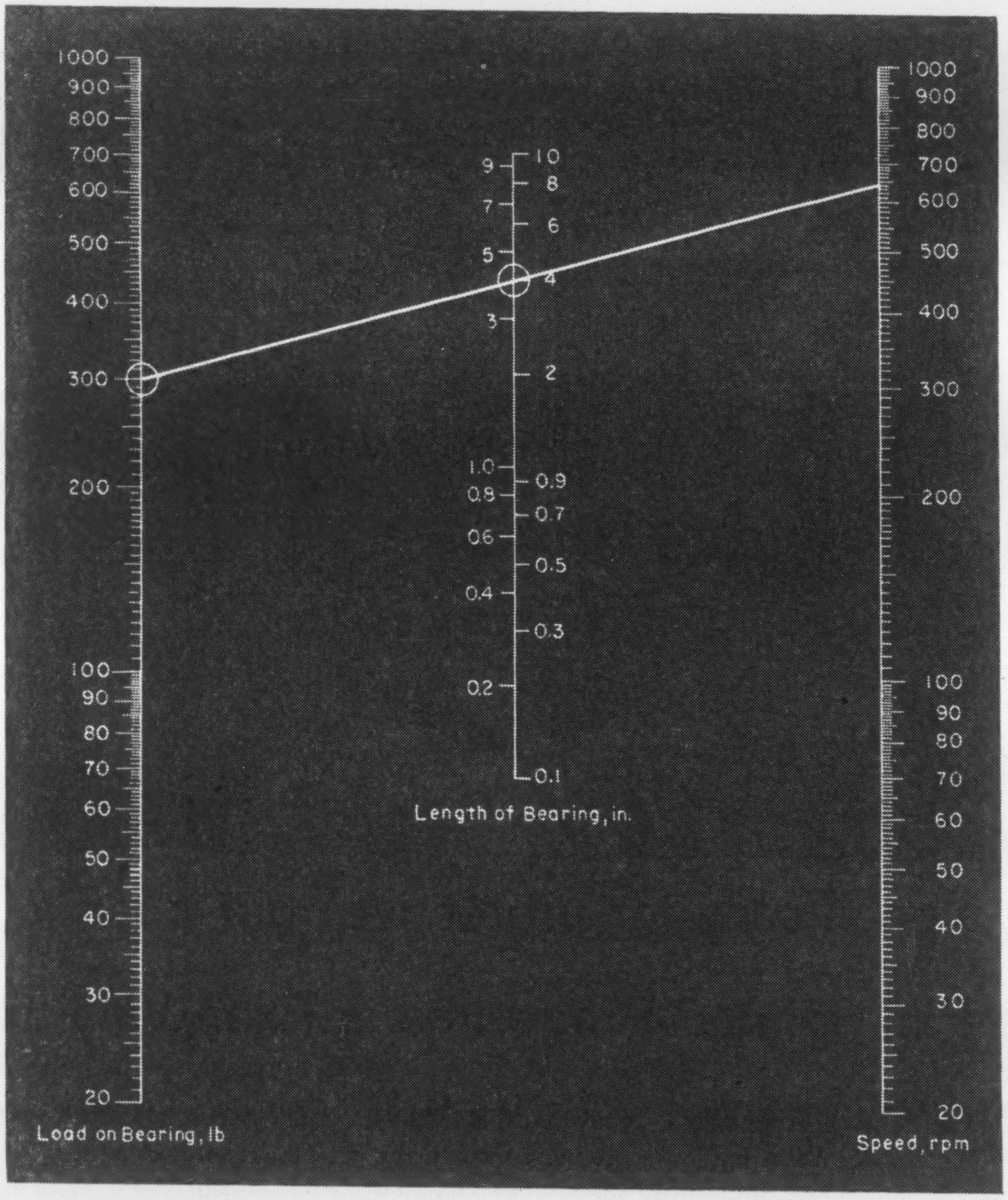
Nomographs for Carbon Bearing Design (continued)

PV = 12,000

(For nonlubricated operation. For operation in contact with any fluid, PV values as high as 120,000 can be used.)



Sample problem

To determine whether a nonlubricated carbon bearing can be used to replace a lubricated bronze bearing. The bronze bearing is 4 in. long and is used to support a 2-in. dia shaft. Bearing load is 300 lb and shaft is turning at 350 rpm.

On the first nomograph lay a straight-edge from the 4-in mark on the length scale to the 2-in. mark on the diameter scale. The intersection point of the load scale is 400 lb. Since the actual load on the bearing is 300 lb the unit loading is less than 50 psi and thus satisfactory.

On the second nomograph (above) lay a straight-edge from the 300-lb mark on the load scale to the 4-in. mark on the length scale. The resulting line intersects the speed scale at 640 rpm. Since the actual speed is 350 rpm the PV value is less than 12,000.

The bronze bearing can be directly replaced with a nonlubricated carbon bearing.

Courtesy of Electro-Nite Carbon Co.

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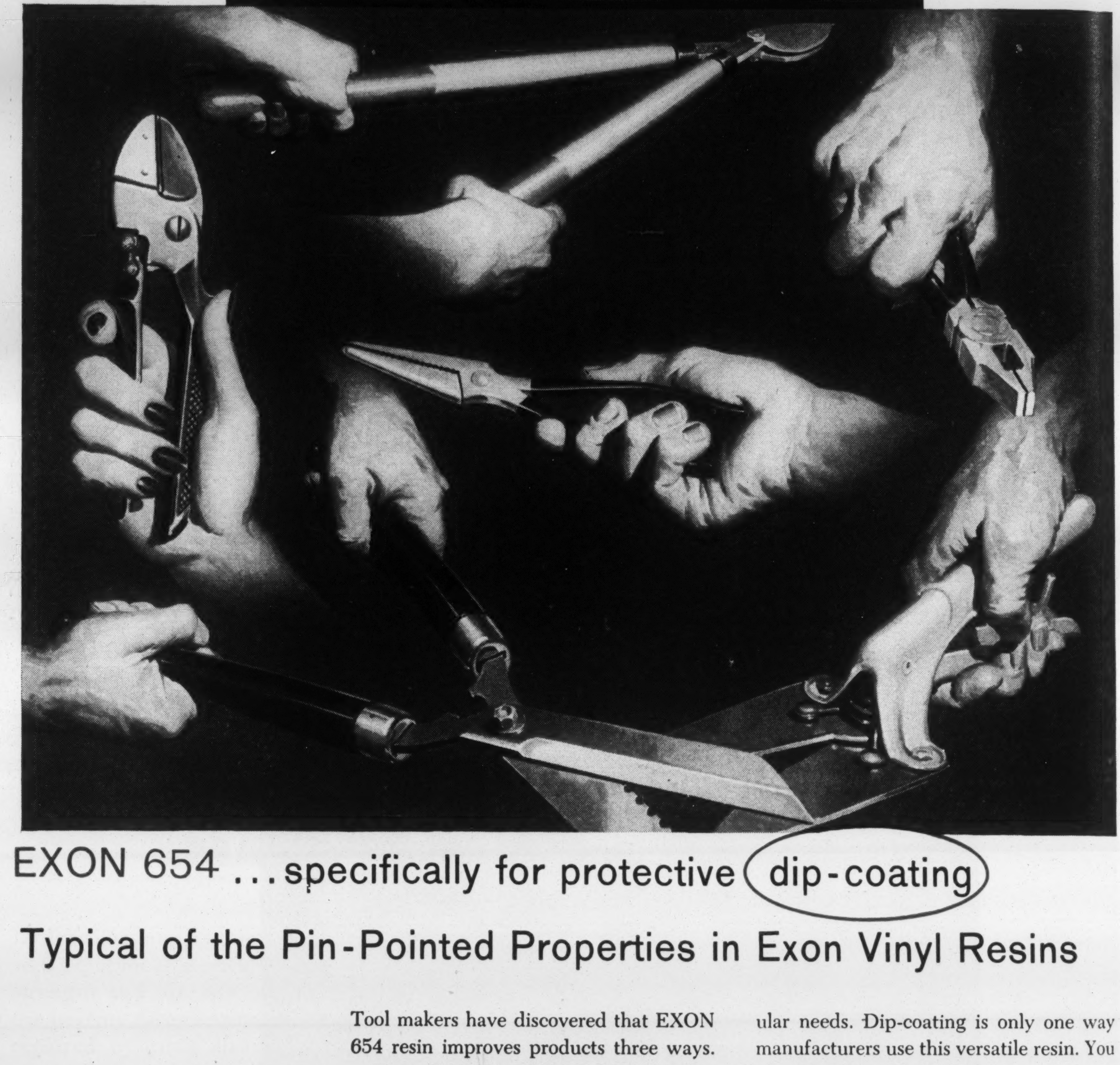
THIS RESIN COMES FIRST...

FOR TOOL HANDLES THAT LAST



EXON 654 ...specifically for protective dip-coating

Typical of the Pin-Pointed Properties in Exon Vinyl Resins

Tool makers have discovered that EXON 654 resin improves products three ways.

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This is another example of how Exon's Pin-Pointed Properties match your particular needs. Dip-coating is only one way manufacturers use this versatile resin. You can spread coat it, slush mold it or foam it.

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What's new IN MATERIALS

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***Turbine disk blanks** forged from W545.*

Jet Engine Alloy Withstands 1200 F, 75,000 Psi for 300 Hr

■ The development by Westinghouse Electric Corp. of a new high strength, high temperature metal for use inside the red hot interiors of jet engines represents a significant advance in the field of gas turbine disk materials.

The new material, designated W545, is essentially an iron-nickel-chromium alloy with small additions of molybdenum, titanium and boron. According to Dr. J. T. Brown, one of the men responsible for the alloy's development, it is the addition of boron that is responsible for the alloy's excellent high temperature strength.

How alloy was developed

In explaining the steps leading up to the development of the new material, Dr. Brown points out that the operating strength or temperature of a high temperature alloy can be easily increased by adding greater quantities of the ingredients which cause hardening of the alloy. However, such additions usually result in a loss of ductility, causing the alloy to become brittle and more susceptible to fracture. This low ductility starts to grow during the hardening process, when imperfections and dislocations of the atoms occur along individual grain boundaries of the alloy.

One solution to this problem is to fill up these spider web lines of brittleness to make the precipitation reaction more generalized within the grains rather than concentrated at the boundaries. This calls for an atom of such size that it would not move in and be a substitute in the alloy lattice for one of the iron, nickel or chromium atoms (which are all about the same size), but which would also have to be larger than atoms of carbon, nitrogen or oxygen, which can actually slip inside the crystal lattice (interstitially) of the element. The atom selected was boron; approximately three-fourths the size of the iron atom, it is too small to be substitutional and too large to be interstitial in nature.

TENSILE PROPERTIES OF W545

	Bar Stock[a]	Disk Forging[b]
Yield Strength (0.2% offset), 1000 psi		
Room Temperature	111	120
1200 F	106	
1300 F	97	
Tensile Strength, 1000 psi		
Room Temperature	162	158
1200 F	120	
1300 F	103	
Elongation (in 1.4 in., %)		
Room Temperature	28	13
1200 F	12	
1300 F	15	
Reduction of Area, %		
Room Temperature	29	14
1200 F	14	
1300 F	18	
Brinell Hardness		
Room Temperature	302/321	321/335
1200 F	302/321	
1300 F	302/321	

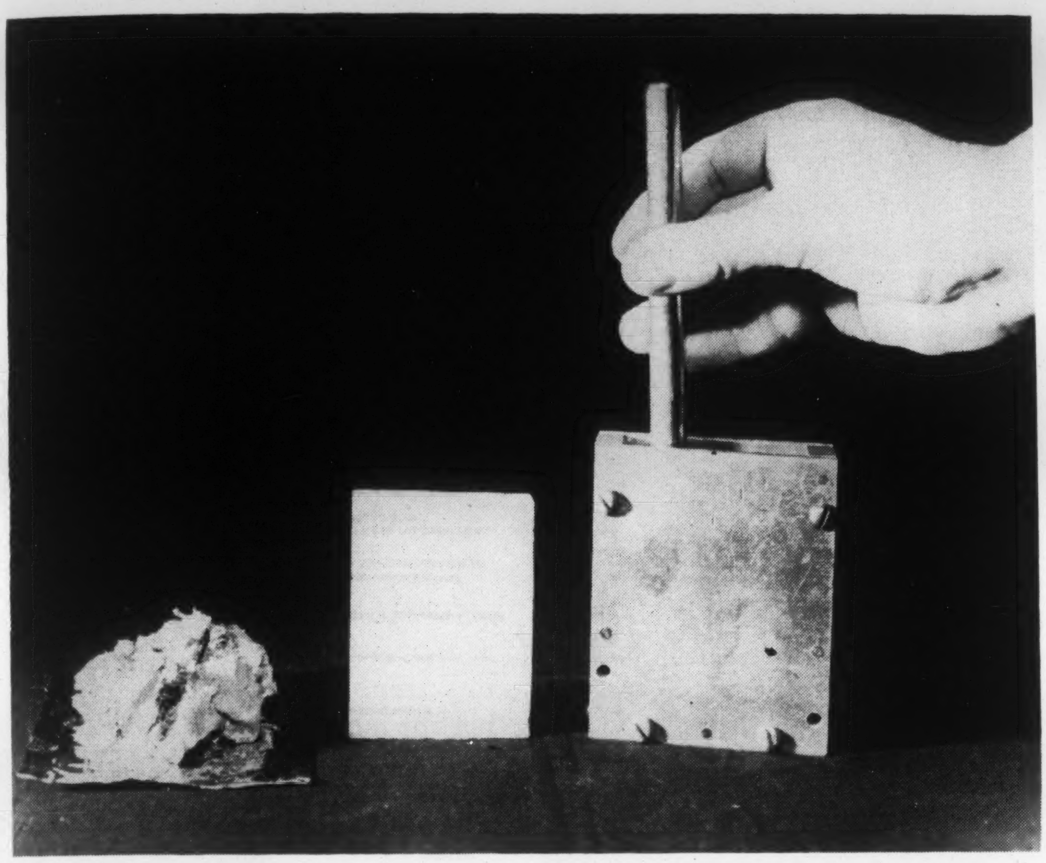
[a] 2.5% titanium [b] 2.78% titanium

PHYSICAL PROPERTIES OF W545

Density, lb/cu in.	0.285
Lowest Melting Temperature, F	2480
Specific Heat (70-212 F), Btu/lb/°F	0.113
Magnetic Permeability (10,000 oersteds)	1.010 ± 0.005
Coef of Ther Exp (70-1200 F), per° F	9.6×10^{-6}
Thermal Conductivity, Btu/hr/sq ft/ft/°F	
Room Temperature	7.5
1472 F	14.5
Electrical Resistivity, Microhm-cm	
Room Temperature	98.0
1282 F	125.0

A jet engine turbine disk whirling at red hot temperatures, undergoes stresses as great as 50,000 psi. Samples of W545 heated to a temperature of 1200 F and subjected to a stress of 75,000 psi have survived for as long as 300 hr without breaking. Dr. Brown feels that this development may well push back the "heat barrier." At the very least, its use should permit an increase in operating temperature of a jet engine by as much as 100 F—equivalent to adding about 100 mph to a jet's top speed.

Ceramic Foam Developed for Electronic and Aircraft Use



Uncured ceramic foam *(left), resembling damp sand, is tamped into a cavity (right) where it is cured. After curing, the finished block (center) is ready for use.*

■ An extremely fine and uniform ceramic foam, called Eccofoam LM, has been developed by Emerson & Cuming, Inc., 869 Washington St., Canton, Mass., for use in electronic and aircraft parts operating at temperatures up to 1600 F. The foam is supplied to the user as two components: Part A as a powder and Part B as a liquid. When mixed, the resultant material resembles damp sand which can be packed or tamped into place until the mold or void is completely filled. When the cavity is filled, the producer recommends that the material be cured for 6 hr at 200 F, then 6 hr at 350 F and finally 2 hr at 550 F. No volume change takes place in the material during cure, according to the company.

The cured material is recommended as an ultra high temperature potting compound, as a core material for high temperature sandwich structures, as a thermal barrier material and as a radome core.

PROPERTIES OF ECCOFOAM LM

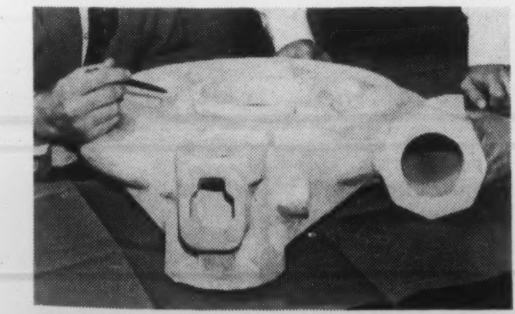
Bulk Density, lb/cu ft	19
Compressive Strength, psi	800
Flexural Strength psi	1100
Dielectric Constant, 100 cps	1.5
Dissipation (power) Factor, 100 cps	0.002

42B Aluminum Casting Alloy Has High Strength, Good Ductility

■ A new aluminum casting alloy, designed for use in critically loaded aircraft and missile structures, is said to combine high strength with good ductility.

Developed by North American Aviation, Inc. and called 42B, the new alloy is of the magnesium-silicide type, modified with beryllium and sodium. Although the alloy's exact composition has not been released, the company says the alloy does not require precise control of alloying elements and is not prone to fluctuations due to minor impurities. It can be cast to minimum wall thicknesses of 1/8 in. in sand and 5/32 in. in a permanent mold without special procedures or tooling. Surface finishes equal to those of the best commercial aluminum alloys can be obtained.

The outstanding property of the new alloy is its balance between tensile strength, yield strength and elongation (see accompanying table). Moreover, the alloy is claimed to possess good

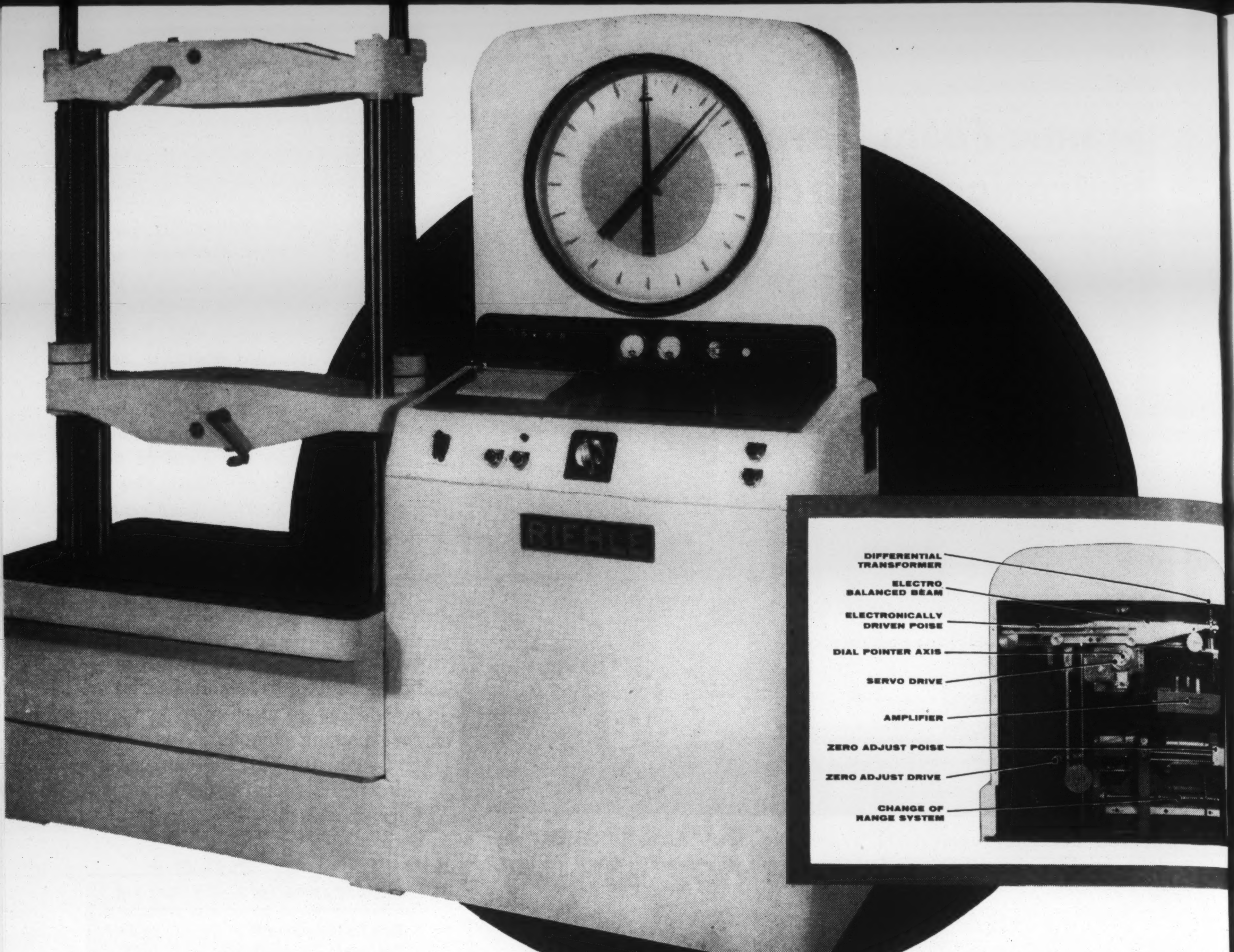


Turbo-pump component *of new aluminum alloy.*

PROPERTIES OF 42B-T6

	Sand Castings	Permanent Mold Castings
Tensile Strength, 1000 psi	46	50
Tensile Yield Strength, (0.2% offset), 1000 psi	36	44
Compressive Yield Strength (0.2% offset), 1000 psi	36	41
Shear Strength, 1000 psi	41	44
Bearing Strength, 1000 psi[a]	98	103
Bearing Yield Strength, 1000 psi[a]	62	73
Elongation (in 2 in.), %	5.0	6.0

[a] Where e/D=2.0.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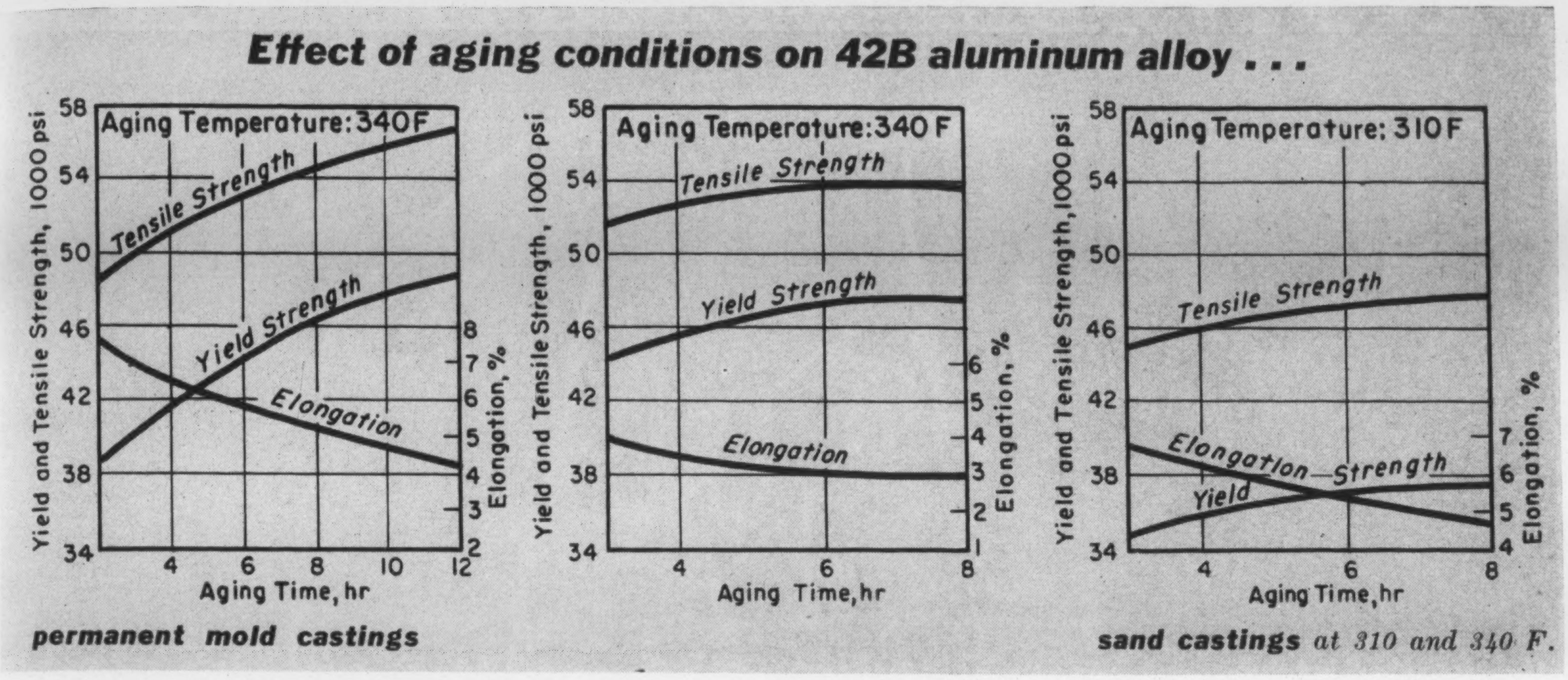
Effect of aging conditions on 42B aluminum alloy . . .



permanent mold castings

sand castings *at 310 and 340 F.*

corrosion resistance, dimensional stability, reliable response to heat treatment, and soundness or radiographic quality equal to that of the best commercial aluminum alloys.

Heat treatment

Alloy 42B is solution treated, quenched and artificially aged. Different properties may be obtained by varying aging times and temperatures. The highest tensile and yield properties, but lowest elongation, are obtained by aging at 340 F. The reverse is true at 310 F.

In general, permanent mold castings may all be aged at 340 F because of the better elongation caused by the permanent mold process. The best balance of properties in sand castings may be found at 320 or 330 F. The highest aging temperature (310 to 340 F) which produces the desired results in a minimum of 3 hr should be used.

PHYSICAL PROPERTIES OF 42B-T6

Density, lb/cu in.	0.097
Coef of Ther Exp, per °F	
68-212 F	11.9 X 15^{6}
68-392 F	12.7 X 10^{6}
68-572 F	13.0 X 10^{6}
Electrical Conductivity, % IACS	39
Thermal Cond (77 F), Btu/hr/sq ft/ft/°F	87

What's new IN MATERIALS

Tiny Magnesium Pellets Yield Strong Extrusions

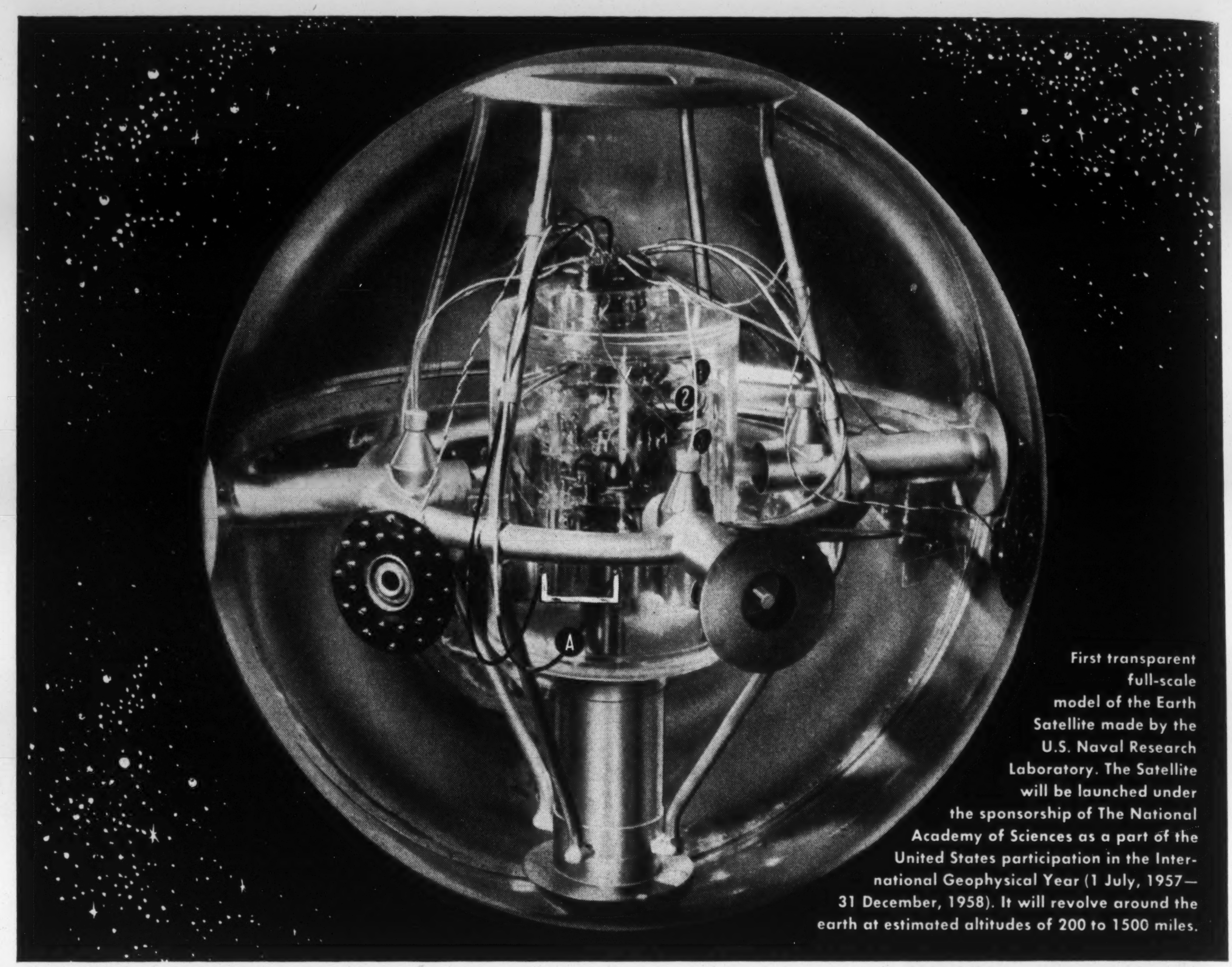
Pellets *have average diameter of 0.016 in. and are extremely uniform.*

■ As a result of a new extrusion process, Dow Chemical Co. is turning out what are claimed to be the strongest magnesium extrusions ever produced for military aircraft and missiles. Known as pellet extrusion, the new process provides extruded shapes with a guaranteed compressive yield strength of 35,000 psi in cross sections up to 10 sq in.—as much as 40% higher than provided by conventional magnesium alloy extrusions.

The pellet extrusions owe their higher compressive yield strength to the fact that magnesium's strength is inversely proportional to its grain size. In pellet extrusion, minute magnesium particles about 0.016 in. in dia, rather than conventional solid billets, are fed into the extrusion press. The particles or pellets are then forced through a die under heat and pressure to form sections with extremely fine grain size.

How pellets are made

In producing pellets for the new extrusion process magnesium is first melted and alloyed with small amounts of zinc and zirconium. Then the liquid alloy is piped into a large atomizer tank, where it is



First transparent full-scale model of the Earth Satellite made by the U.S. Naval Research Laboratory. The Satellite will be launched under the sponsorship of The National Academy of Sciences as a part of the United States participation in the International Geophysical Year (1 July, 1957—31 December, 1958). It will revolve around the earth at estimated altitudes of 200 to 1500 miles.

How measure the impact of micro-meteorites on the first "Earth Satellite"?

When physicists at the U.S. Naval Research Laboratory consider an instrument or a material to record accurately the secrets of outer space—it's not size alone that counts, but dependable, reliable precision.

The strip of "Nichrome"* evaporated on glass ("A" in the photo above) which may be fitted to the outer skin of the Satellite, measures only ¼″ wide x 1½″ long. Its thickness: 100 Angstrom units (1/10,000 mm). Its function: to measure the surface erosion caused by the impact of micro-meteorites. The resistance of the Nichrome ribbon increases as the film becomes pitted by meteor particles.

"Nichrome is being considered for making this gage," states the Naval Research Laboratory, "because it supplies electrical resistance in a desirable range; adheres satisfactorily to glass in thin film form; and has a very low thermal coefficient of resistance."

There'll be no one on hand, 300 miles out in space, to check on or supervise the performance of the Nichrome strip. Nichrome needs no one. It will do its job dependably there—just as it will in *your* electronic or electrical equipment, after it is in your customers' hands.

And remember, Nichrome is only one of the 132 special purpose alloys developed by Driver-Harris since 1899 for electrical heating, resistance, and electronic applications. Do you need a special alloy? Send us your specifications.

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***Conventional equipment** is used to form pellet extrusions.*

poured onto a high speed spinning disk. Centrifugal force hurls small molten droplets of magnesium off the spinning disk; in flight from disk to tank wall the droplets cool from about 1400 F to about 300 F and assume a spherical shape. As the droplets fall to the bottom of the tank, they cool further and are then piped through a screen, which insures uniformity.

The solid magnesium pellets are heated to about 650 F and blown directly into the extrusion press. Under the high temperatures created by frictional heating in the extrusion process, the pellets are forced together as they pass through the press and are bonded into structural shapes.

The chief significance of pellet extrusions, according to Dow, is the latitude they allow air frame designers: significant weight reduction can now be achieved without sacrificing necessary strength.

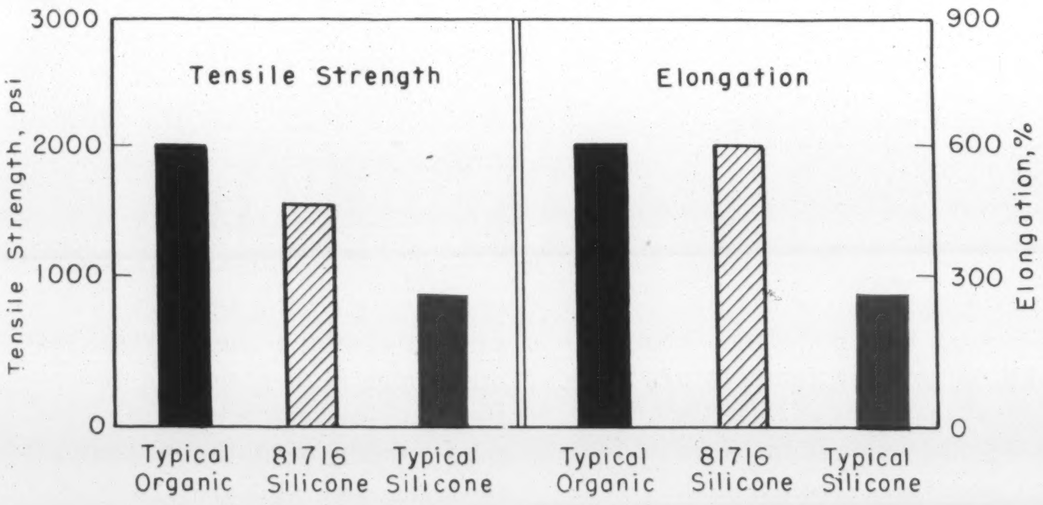
COMPRESSIVE YIELD STRENGTHS OF PELLET, BILLET EXTRUSIONS

Shape	Pellet Extrusions	Billet Extrusions
11-In. I-Beam	42,000 psi	30,000 psi
4 x 4 x ⅝-In. Angle	38,000 psi	27,000 psi
4-In. I-Beam	40,000 psi	30,000 psi

PROPERTIES OF PELLET EXTRUSIONS (ZK60XB-B)

Dia or Thickness in Least Dimension, in.[a] →	Under 0.250	0.250-1.000
Tensile Strength, 1000 psi	45	45
Tensile Yield Strength, 1000 psi	33	35
Elongation (in 2 in)., %	4	4
Compressive Yield Strength, 100 psi	31	35[b]

[a] Cross section: 2-10 sq in.
[b] Guaranteed minimum.



***How 81716 compares** with typical organic and silicone rubbers.*

Two New Silicone Rubbers Have High Strength Properties

■ Two new high strength silicone rubber compounds are said to have physical properties similar to those of organic rubbers. Development of the new silicone rubber compounds was announced recently by Dow Corning Corp., Midland, Mich., and General Electric Co., Silicone Products Dept., Waterford, N. Y. GE's silicone rubber, called 81716, is supplied in raw stock form with or without a catalyst and Dow Corning's silicone rubber, designated Silastic 916, is supplied in the compounded form.

(continued on p 188)

HOW 81716 COMPARES WITH AMS 3345

	AMS 3345 Min Requirements	81716 Typical Properties
Tensile Strength, psi	1000	1550
Elongation, %	500	625
Hardness, Shore A	50 ± 5	51
Tear Resistance, lb/in.	150	180
Aged 70 hr at 400 F		
Tensile Change, %	−40	−34
Elongation Change, %	−50	−35
Hardness Change, points	0 to +20	+9
Aged 70 hr at 300 F in ASTM Oil No. 1		
Tensile Change, %	−40	−40
Elongation Change, %	−50	−33
Hardness Change, points	−10 to +5	−3
Volume Change, %	0 to +15	+12
Low Temperature Brittleness, F	−105 Pass	−105 Pass
Compression Set (aged 70 hr at 300 F)	73	60

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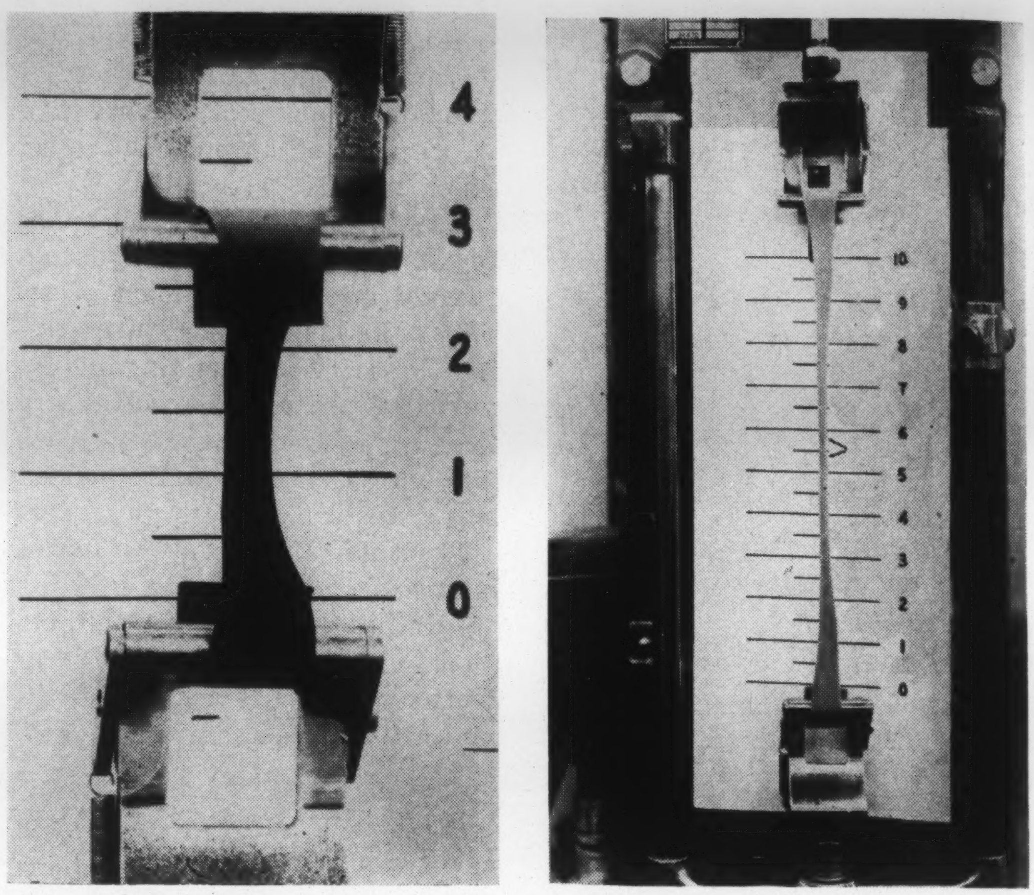


Tear resistance: *how a standard, low temperature type silicone rubber (left) compares with GE's new high strength silicone rubber (right).*

Silicones—cont'd from p 187

GE's silicone

GE's 81716 silicone rubber meets AMS 3345 requirements for tensile and tear strength, elongation, dry heat resistance, compression set and low temperature flexibility (see table). It also meets AMS 3345 values in three of four oil resistance requirements; it is marginal in the fourth.

When plasticized and ready for fabrication, 81716 is said to have unusually long shelf life; for some operations this may be as long as several days. According to the company, the material can be calendered, extruded, transfer and compression molded, hot air vulcanized and steam cured.

Available in limited quantities for evaluation, the silicone gum is recommended for a variety of aircraft seals, including camera well, cargo hatch, window, door and wheel seals; forming blankets; bellows; diaphragms; and firewall seals (see M&M, Jan '55, p 142, for other high strength silicone rubber compounds.

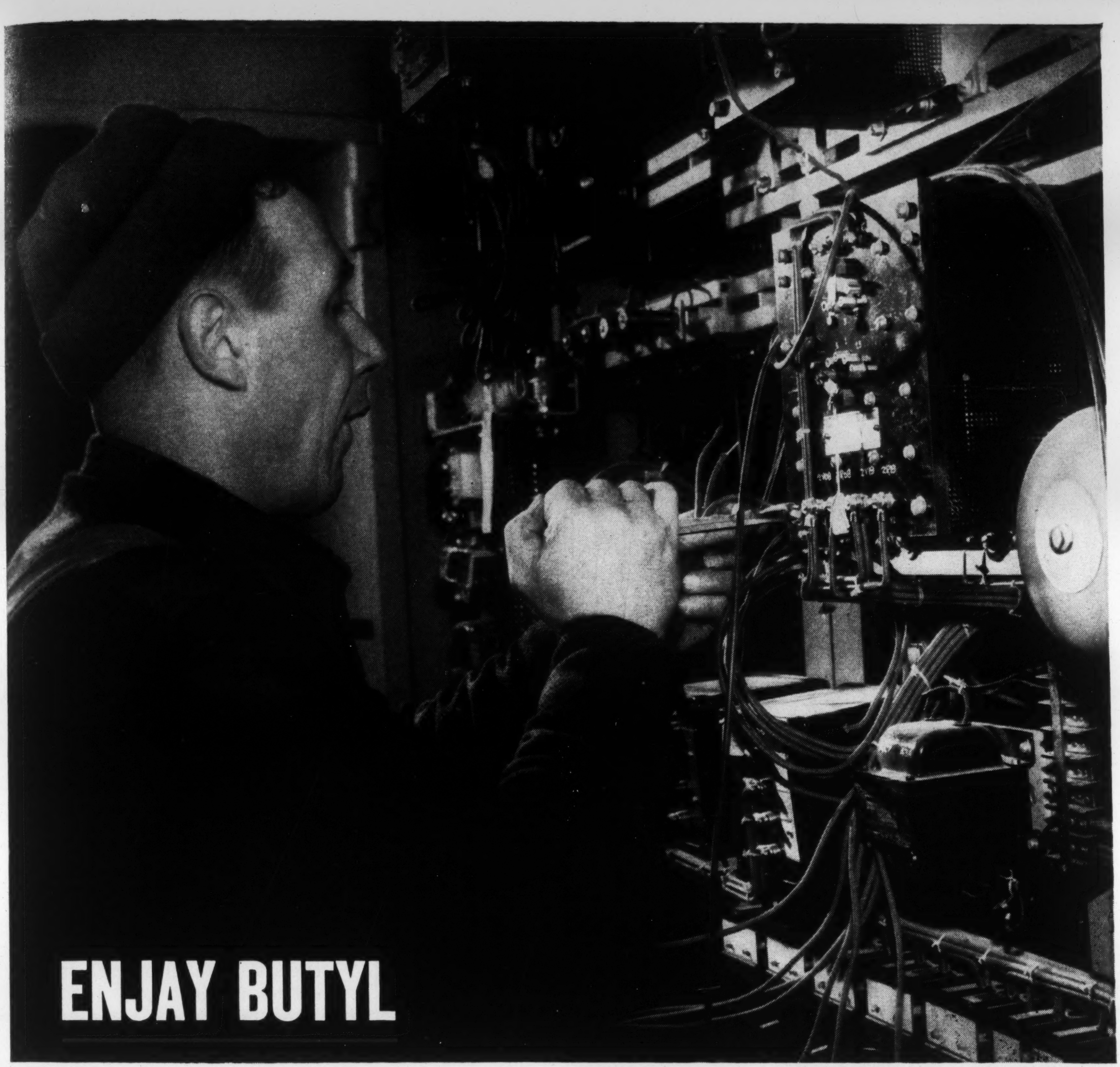
Dow Corning's silicone

Available in pilot plant quantities, Dow Corning's Silastic 916 is said to combine the thermal stability and high dielectric properties that are characteristic of silicone rubber with the mechanical strength and abrasion resistance of conventional organic rubbers. It is also nontoxic and is serviceable at low (−130 F) and high (500 F) temperatures. Typical

TYPICAL PROPERTIES OF SILASTIC 916

Tensile Strength, psi	1500
Elongation, %	550
Durometer A	54
Tear Strength, lb/in.	180
Compression Set, %[a]	25
Brittle Point, F	−178
Dielectric Strength, v/mil	450
Dielectric Constant	
100 cycles	3.01
1 mc	2.99
Dissipation (power) Factor	
100 cycles	0.0015
1 mc	0.0030

[a] Aged 22 hr at 300 F



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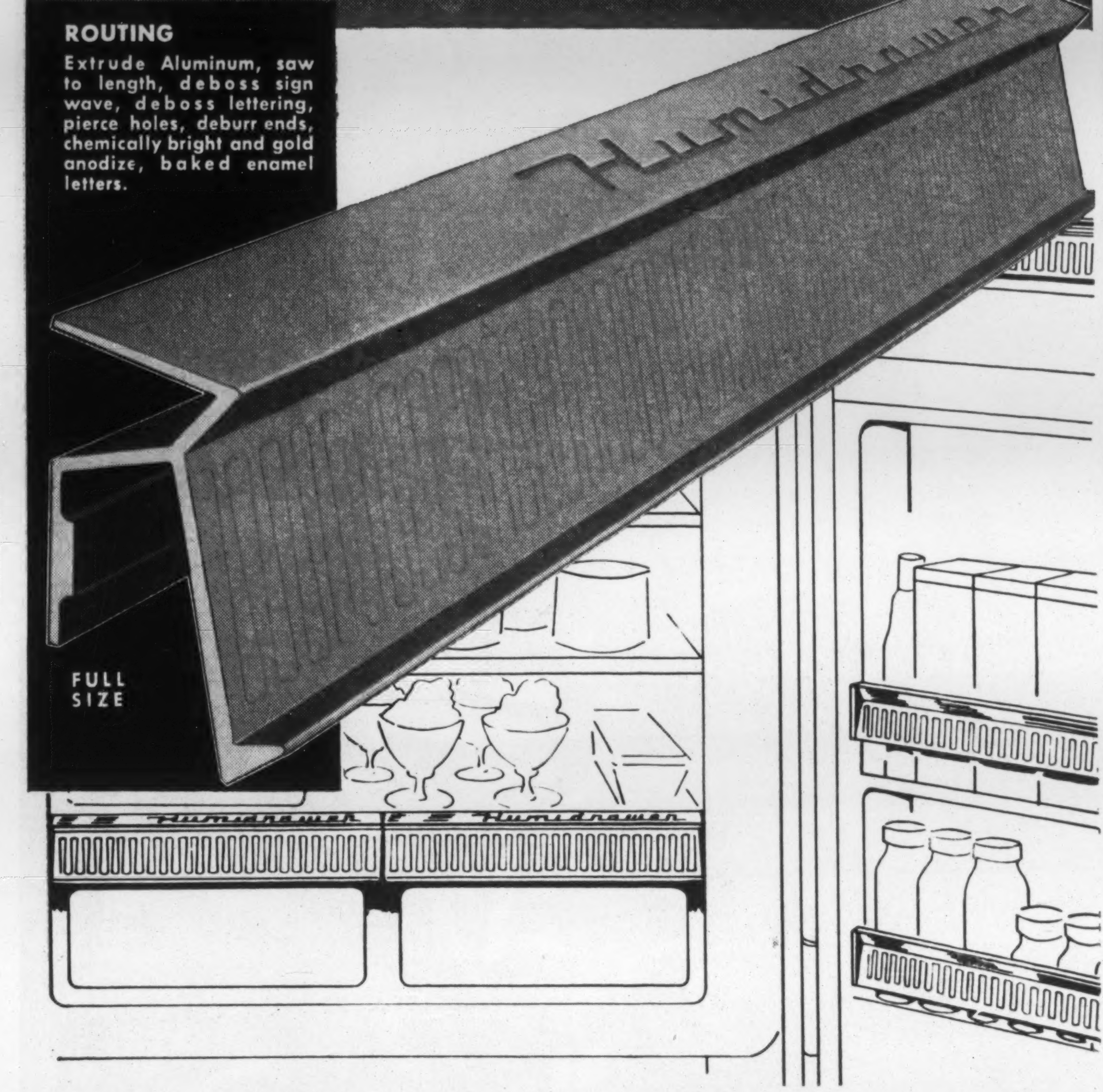

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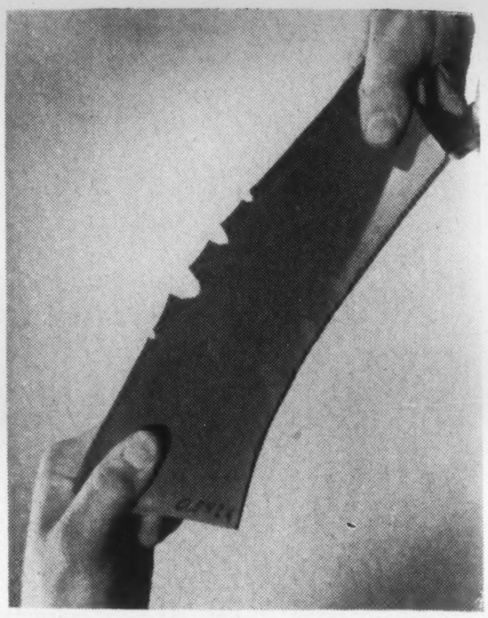

Tear resistance *of Silastic 916 silicone is said to be almost double that of comparable silicone rubbers.*

properties for Silastic 916 are shown in the accompanying table.

According to the company, the silicone does not "nerve up" and can be milled and compounded easily after prolonged shelf aging. It is suitable for molding, extruding and calendering and can be hot-air vulcanized. It is recommended for oven door gaskets, aircraft door seals, wire and cable coatings and oxygen masks.

Thin Welded Tubing in Continuous Lengths

As a result of a new process, light gage welded tubing is now available in stainless steel, carbon steel, titanium, brass, bronze, and other weldable alloys, in wall thicknesses ranging from 0.005 in. for 1/4 in. o.d. up to 0.015 in. for 1 1/4 in. o.d.

Developed by Universal Tube Corp. of Chicago, the new process is claimed to produce stainless steel tubing that conforms to U. S. Government Specification Mil T-6737A for aircraft pneumatic ducts, high pressures, temperatures to 1500 F, and corrosive conditions.

Although details of the new process have not been revealed,

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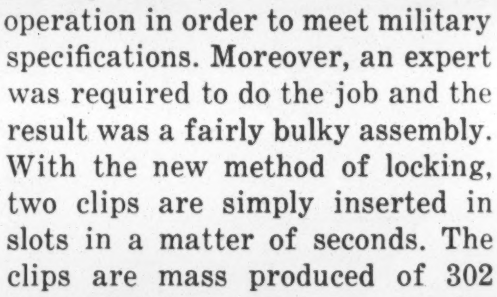
the following advantages are claimed: 1) continuous lengths to 200 ft, 2) better mechanical properties for corresponding metal thickness and diameter and 3) lower cost than seamless drawn tubes in equivalent sizes.

Stainless Steel Clip Improves Turnbuckle

Ingenuity of design plus stainless steel has resulted in a locking clip for turnbuckles which is said to provide at least twice as much torsional strength as safety wire, as well as a 90% reduction in assembly time.

As suggested by the photo, the old safety wire method required a complicated and time-consuming operation in order to meet military specifications. Moreover, an expert was required to do the job and the result was a fairly bulky assembly. With the new method of locking, two clips are simply inserted in slots in a matter of seconds. The clips are mass produced of 302 type stainless steel on regular spring machines.

Other advantages listed for the clips include: 1) greater precision or turnbuckle adjustment than is possible with safety wire; 2) streamlined design eliminates hazards of aircraft controls fouling on projections; and 3) the assembly is much lighter than the old type (not only is the stainless clip lighter than the safety wire, but the weight of clip is balanced out by the amount of metal re-



***Improved turnbuckle assembly** (below) is easier to lock, less bulky and lighter than older models.*

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Plastiatrics

DOW'S CLINICAL APPROACH TO HEALTHY PLASTICS APPLICATION

PROPER BONDING OF STYRON PARTS REQUIRES THOROUGH STUDY OF ADHESIVES

ADHESIVE JOINT DESIGN CRITICAL IN OBTAINING MAXIMUM STRENGTH, DURABILITY AND APPEARANCE

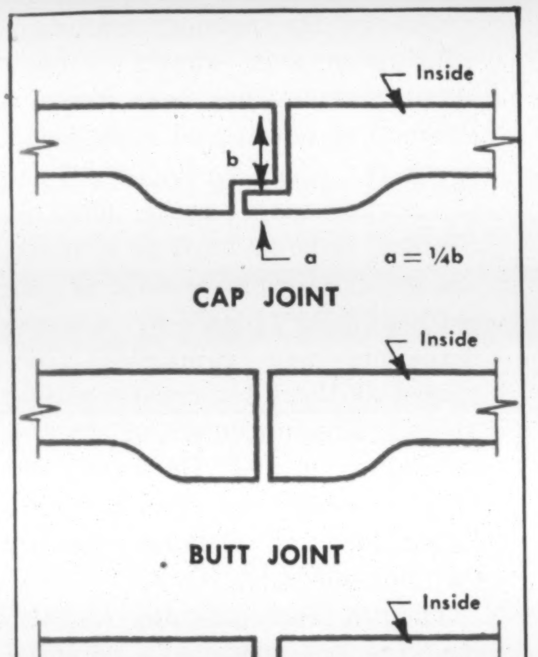
The design of adhesive joints for Styron® plastic assemblies is dependent upon a thorough knowledge of the solvent and chemical action of the adhesive to be used. Through Plastiatrics studies, under the direction of Dow Plastics Technical Service, exhaustive tests have been made on adhesives for Styron. With this information, plastics engineers can more intelligently approach the problem of adhesive joint designs.

Most common of the adhesives studied are the solvent types. They are classed, generally, as fast, medium, and slow drying. Choice of a solvent adhesive is governed largely by the requirements of the finished part. Factors such as appearance, strength and production time must be considered when selecting this type of adhesive.

Certain joint designs require more viscous adhesives. These are made by adding resins, plasticizers and other modifiers to solvents. These adhesives are used when better watertight or airtight seals are required.

Although the objective of the studies was to determine the characteristics of adhesives for Styron and test the effectiveness of various adhesive joint designs, other valuable data was collected. Toxicity of these solvents must be considered in order to protect those who work with them. In addition, various methods of adhesive application were examined.

Plastiatrics studies and research continue in this and similar areas in an effort to find practical solutions to problems in plastics engineering. Determining the desirable properties of adhesives for Styron is just one of a series of such studies. For your copy of the technical bulletin "Adhesives for Styron" and a list of other areas now under investigation, write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Plastics Sales Department PL1541H.



TYPICAL ADHESIVE JOINT DESIGNS FOR STYRON

Design of the joint plays an important role in the effectiveness of the adhesive, the appearance, and the ease and cost of the assembly. Design also determines whether the adhesive will be stressed in tension or in shear when under load.

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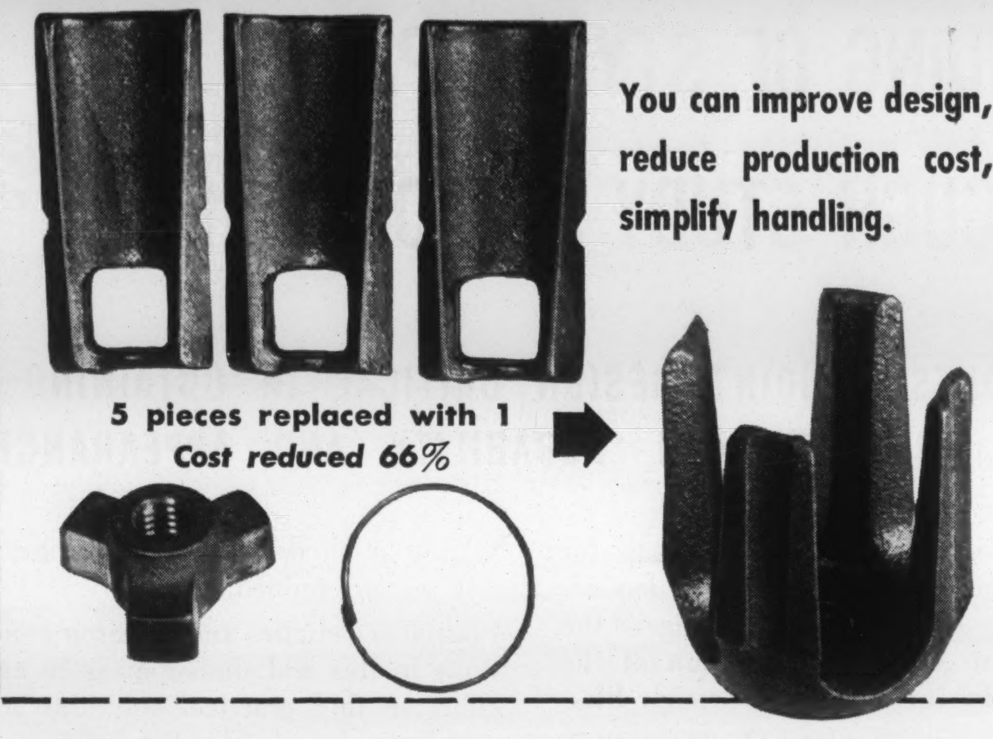

5 pieces replaced with 1
Cost reduced 66%

Here is a typical example of how Malleable Foundry engineers have helped manufacturers to improve parts and entire products by switching to Malleable. The experience of our Society's members covers *hundreds* more, with varying case histories that repeat and repeat these basic gains:

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moved in milling the slot in the turnbuckle stem and in broaching the slot in the barrel).

The patented Stuke Lock is marketed by Associated Aircraft Industries, Inc., Memphis, Tenn.

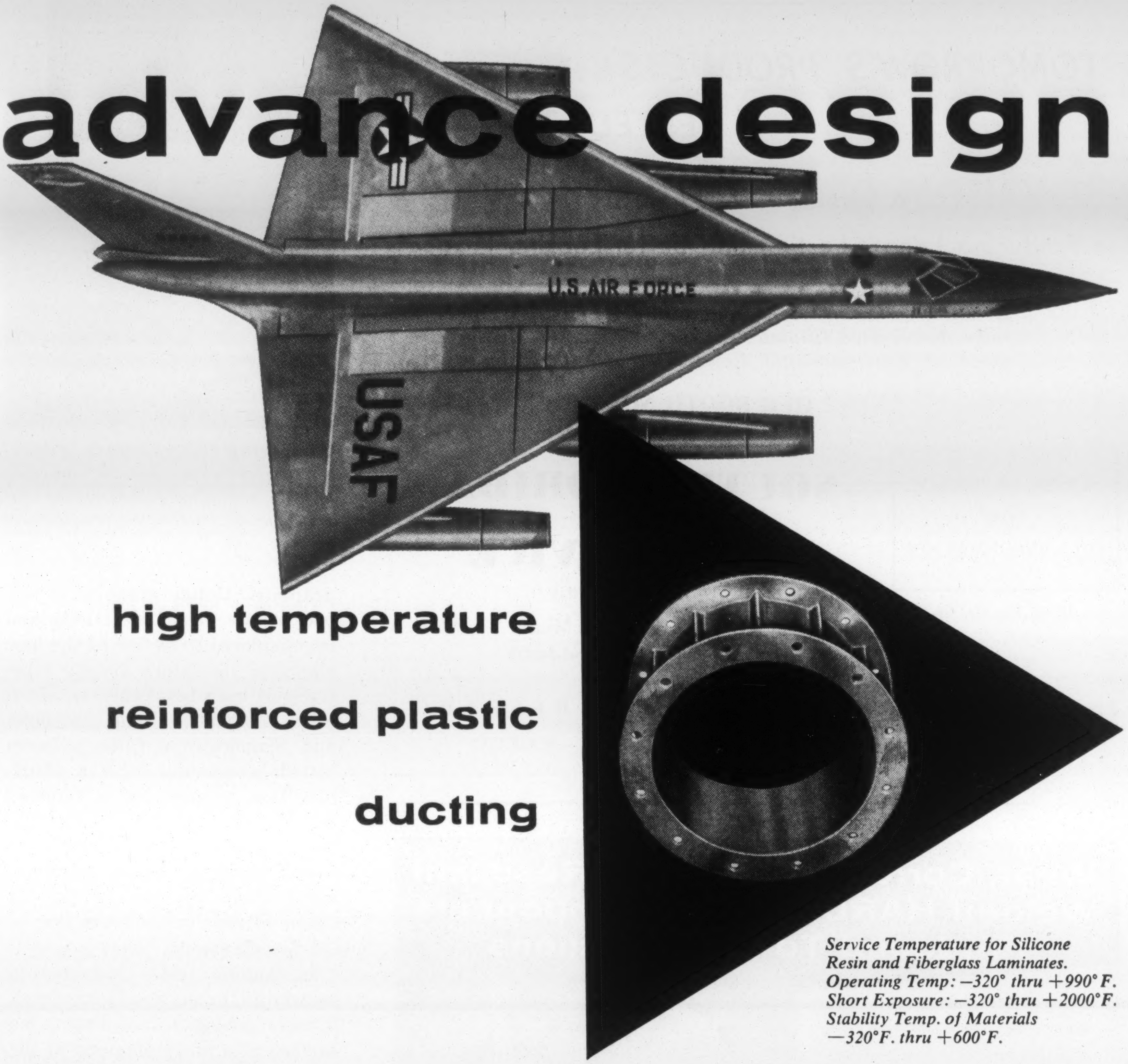
Man-Made Material Is Hard As Diamond

One of the hardest man-made substances ever known — cubic boron nitride—has been made by subjecting boron and nitrogen to pressures above 1,000,000 psi and to temperatures above 3000 F. Claimed to be as hard as diamond, the material remains solid at temperatures of 3500 F, whereas diamonds are completely consumed at these temperatures (see photo). Announcement of the new substance, called Borazon, was made recently by the Research Laboratory of General Electric Co., Schenectady, N. Y.

Though the company is still studying the material's potential uses, it is believed that its resistance to high temperatures "will make possible better methods of mounting stones in industrial tools and may also allow bits and wheels to be operated at higher speeds, performing their cutting and polishing jobs more quickly and efficiently." One important application of the material may be its use in cutting wheels for ceramics, glass and tough metallic alloys. Another is bits for machine tools such as milling machines.

Never before observed in nature, the material contains 41.5 boron and 39.6% nitrogen by weight. A perfect pure crystal of boron nitride contains 43.6 boron and 56.4% nitrogen by weight. The material is generally black, brown or dark red, although milky white, gray and yellow crystals have been made.

Ordinary boron nitride is a white solid material similar in density and crystal structure to



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—320°F. thru +600°F.

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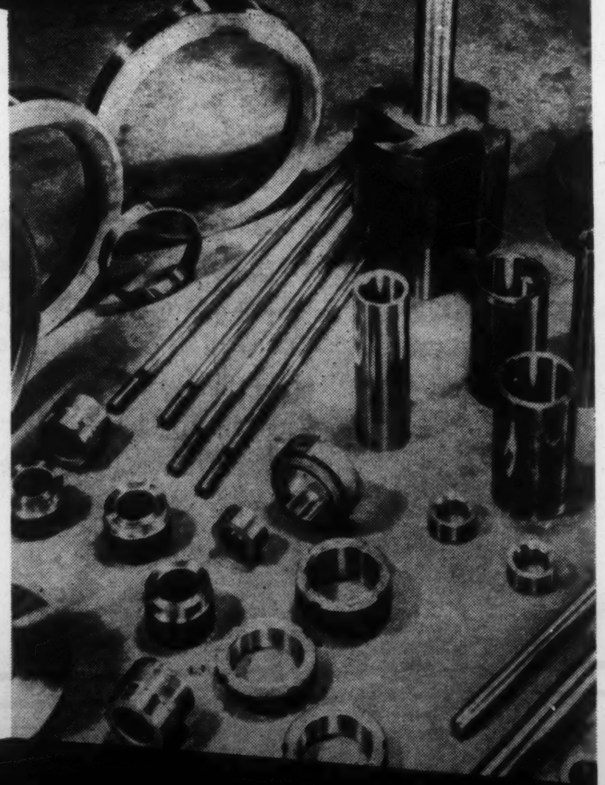

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Comparing *heat resistance of Borazon (left) with that of diamond (nearly melted at right) shows that diamond melts when the temperature exceeds 1600 F.*

graphite. Unlike graphite, it is a poor conductor of electricity and is considered to be one of the best electrical insulators known, especially at high temperatures. However, extremely high pressures and temperatures form a boron nitride compound with a structure that is cubic like a diamond rather than hexagonal like graphite. Cubic boron nitride has nearly the same density as a diamond (3.45 gm per cu cm for boron nitride vs 3.52 gm per cu cm for diamond).

In lapping tests conducted to determine the material's hardness, Borazon powder polished away the surface of a large diamond at the same rate as diamond powder. The hardness of the new material is estimated to be about the same as a diamond since it scratches diamond almost exactly the same as diamond scratches diamond and diamond scratches Borazon.

Prehardened Steel for Die Casting Dies

A new prehardened die casting die steel, available at a hardness level of Rockwell C 42-46, requires no further heat treatment after machining. According to the producer, Latrobe Steel Co., 1944 Haller St., Latrobe, Pa., this gives the steel a special advantage when used for die casting dies because size changes and distortion resulting from heat treat-

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induct-o-ring*

*U.S. and foreign patents pending

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ment are completely eliminated.

Machinability of the new material (Viscount 44) is made practical in its prehardened state through the addition of evenly dispersed sulfide particles. Basically, the steel is an H-13 type, 5% chromium, hot worked steel containing 1% vanadium. The vanadium increases its resistance to wash and heat checking and improves elevated temperature properties.

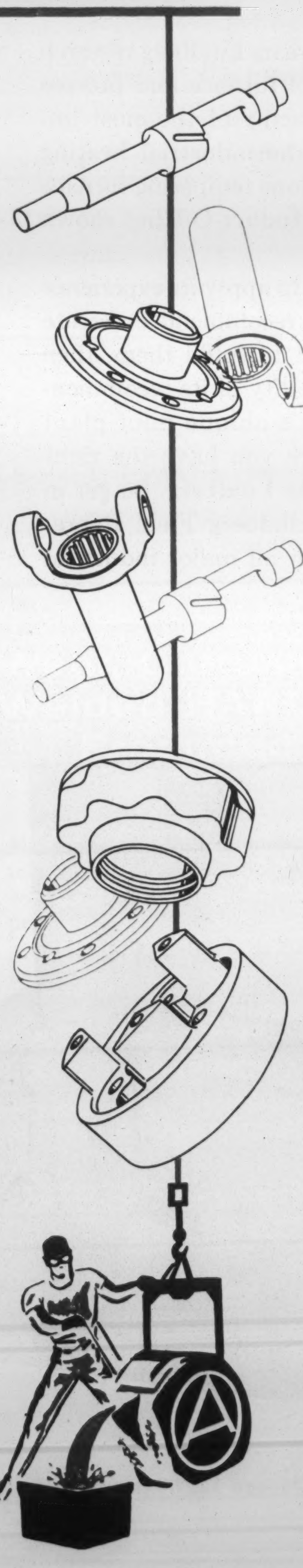
Coated Asbestos Fiber Used as Gaskets, Seals

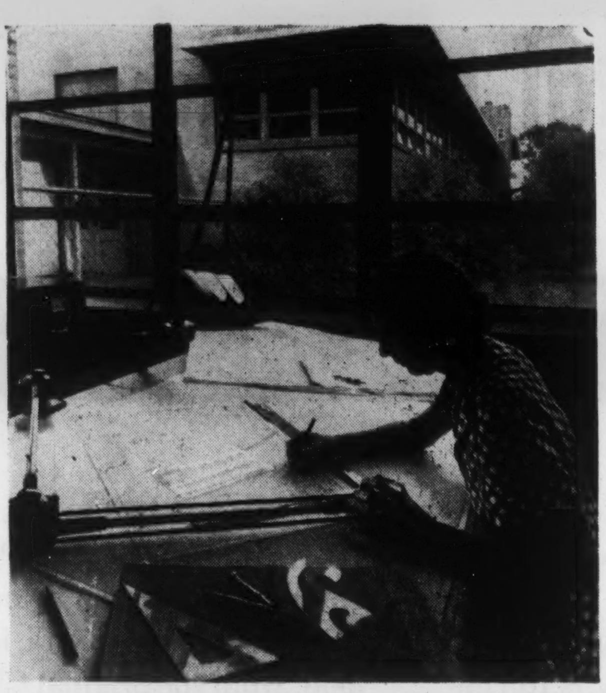
An improved rubber coated asbestos fiber material has been introduced by Armstrong Cork Co., Industrial Div., 6207 Arch St., Lancaster, Pa., for use as gaskets and seals (see M&M, Sept '52, p 146). The material, called Accopac, is said to be more flexible and easier to handle than conventional asbestos fiber gasketing materials. It is manufactured by a patented "beater saturation process" that is said to eliminate lumping and bunching of the asbestos fibers.

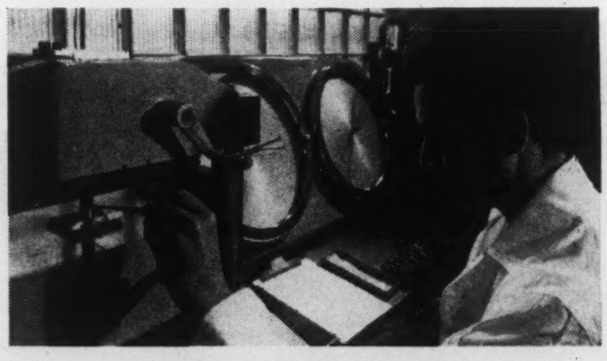
According to the producer, the improved material has good sealing properties at temperatures up to 500 F and at pressures up to 500 psi. It is available in rolls, sheets or die-cut parts.

(more What's New on p 200)

Asbestos fiber *material withstands sharp bending around a pencil without cracking.*







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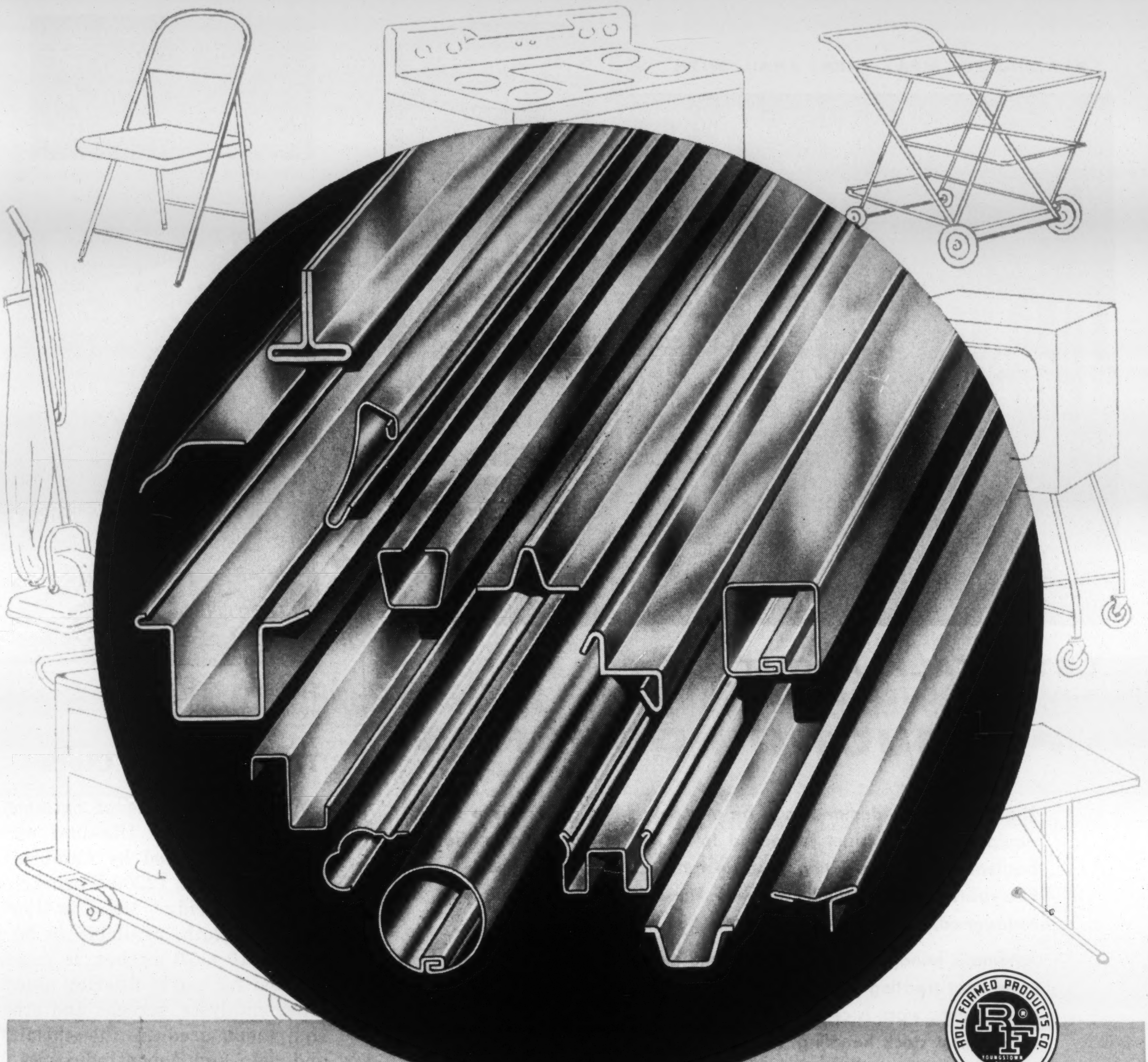

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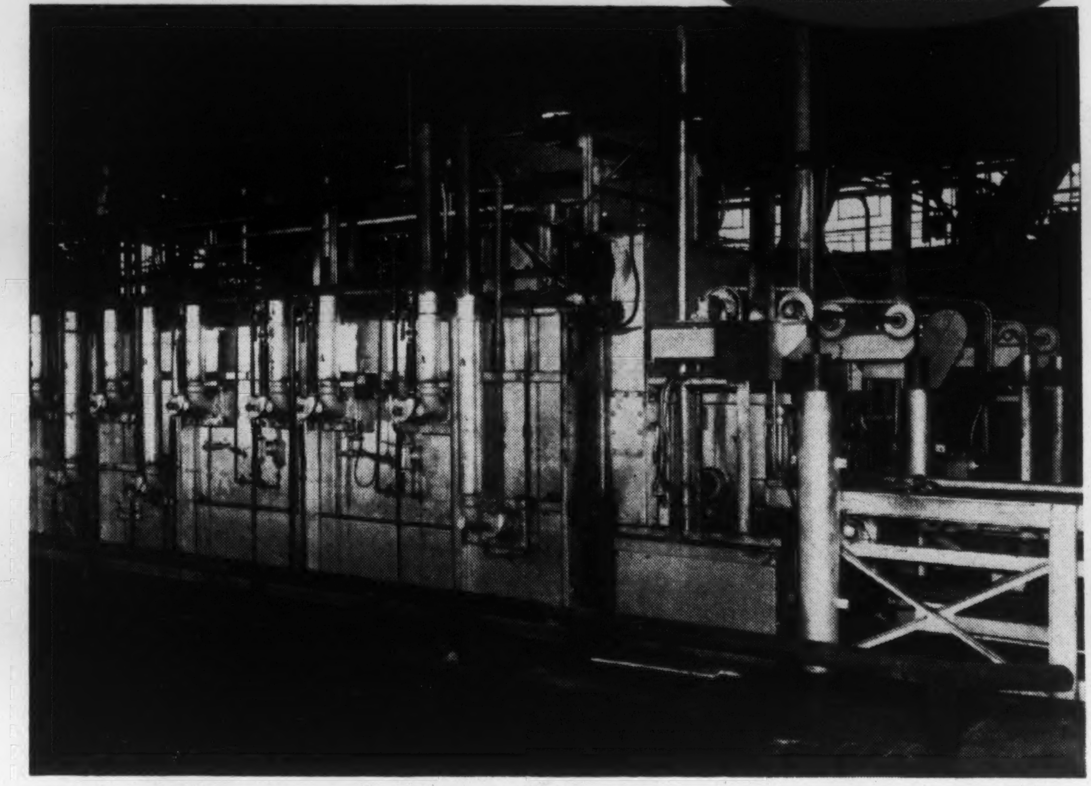
BLAZING THE HEAT TREAT TRAIL WITH HOLCROFT



LET'S TALK ABOUT

PRODUCTION DEMANDS

High production demands can be met only when every piece of equipment in the plant is geared to its job. In many plants, the bottleneck is heat treating because furnaces which were modern five years ago are virtually obsolete. These units must be replaced, redesigned, or added to.

Automatic handling of materials is one answer, of course. Today, some heat treating systems are tied right into production lines. In other plants, work is centralized with automated equipment eliminating most stock handling. A single operator loads green work and removes finished parts.

Some furnaces accomplish dual jobs. A recent Holcroft installation was built to temper two entirely different classes of carburized parts. The furnace was designed with a double chamber with each side operating at the required temperature. Flags, placed on the trays requiring low temperature tempering, keyed the line so that the work automatically positioned itself in front of the correct chamber. Another installation featured a double deck furnace—designed so that two entirely different heat treat processes were accomplished in space where but a single furnace would normally go.

And so it goes: a little idea to save a minute or to eliminate a manual operation—a brainstorm that combines two or more furnaces or steps up furnace capacity. This Holcroft concept can help you produce more for less and with better quality. Better write today.

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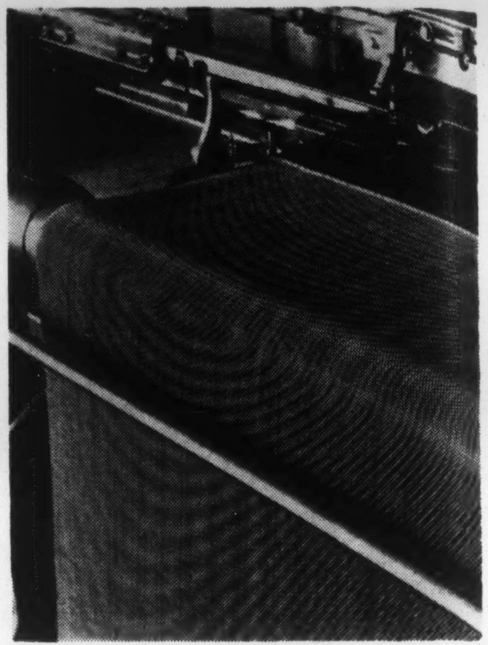
What's new IN MATERIALS



***Spinning** titanium wire into closely woven cloth.*

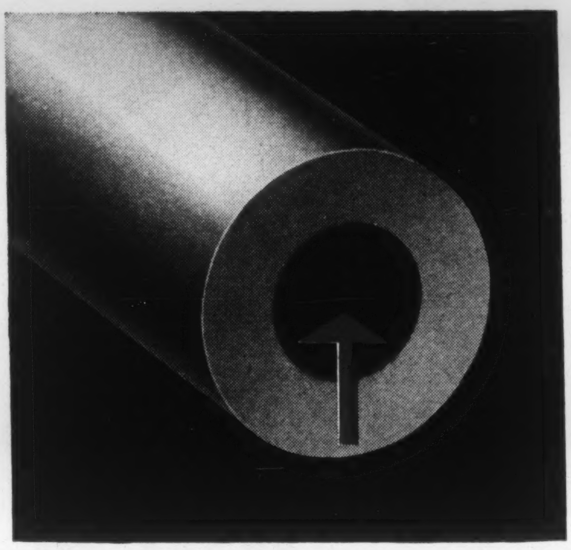
Titanium Wire Cloth

Wire cloth, made of extremely pure and ductile titanium wire, is being produced by Cambridge Wire Cloth Co., 12200 Washington Blvd., Cambridge, Md. The titanium wire cloth, available in 30 x 30 and 10 x 10 meshes, is recommended for use in filtering assemblies, catalysts, screens and other equipment used in the chemical and pulp and paper industries.

Polystyrene Compound for Thin Walled Parts

A free flowing polystyrene injection molding compound, designated SMD 3700, has been developed especially for thin walled parts such as plastics containers and lids. Produced by Bakelite Co., Union Carbide & Carbon Corp., 260 Madison Ave., New York 16, N. Y., the material can be molded over a wide range of molding temperatures and is said to be freer flowing than general-purpose polystyrenes at all injection molding temperatures.

According to the company, it produces a hard glossy surface as other polystyrenes upon cure and can be printed and coated by the



a hole here makes waste... a hole here saves waste

Crucible Hollow Tool Steel cut sections eliminate the waste and cost of drilling out solid rounds to make ring-shaped or tubular steel parts, or tools with a center hole. By using these hollow bar sections, cut to length, you do away with unnecessary cutting, drilling, and boring operations, increase machine capacity, and cut scrap losses.

These hollow sections, in just about any O.D. and I.D. combination, or thickness you want, are *immediately* available in five most popular Crucible grades: KETOS oil hardening, SANDERSON water hardening, AIRDI 150 high-carbon high-chromium, AIRKOOL air hardening, and NU DIE V hot-work tool steels.

Call your nearby Crucible warehouse for more information, or for speedy delivery. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

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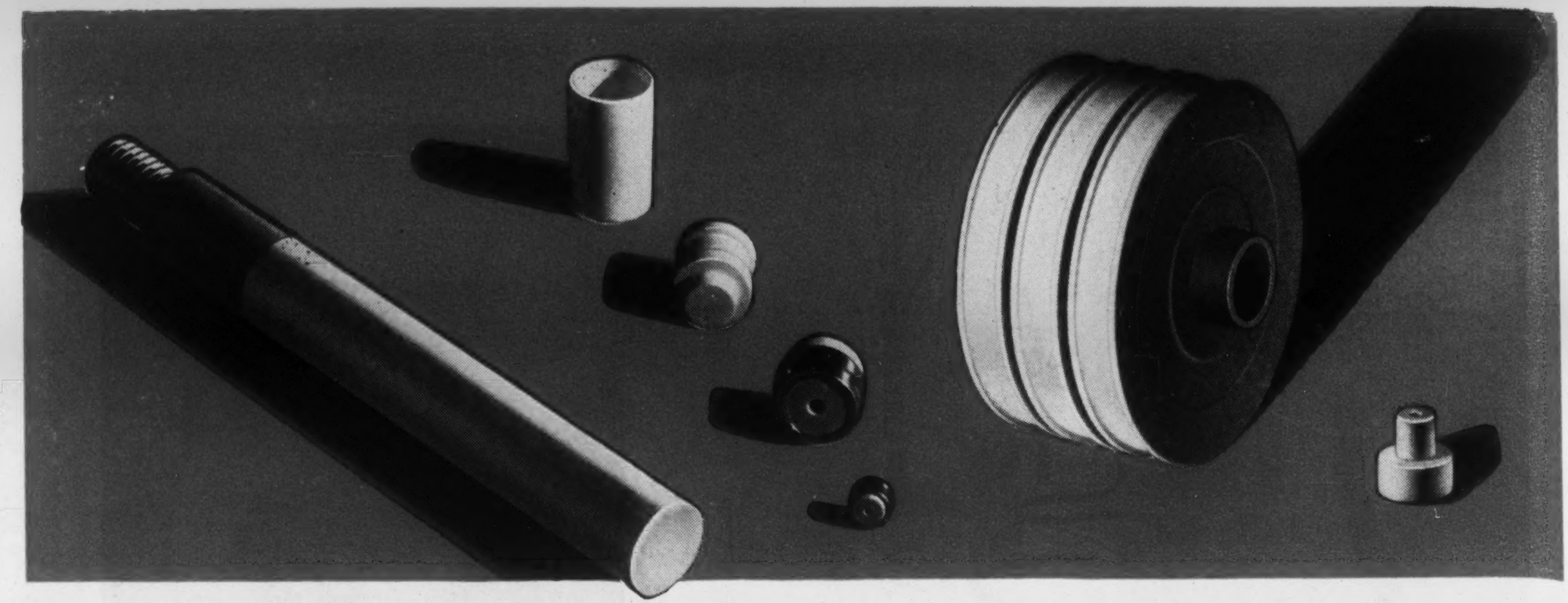


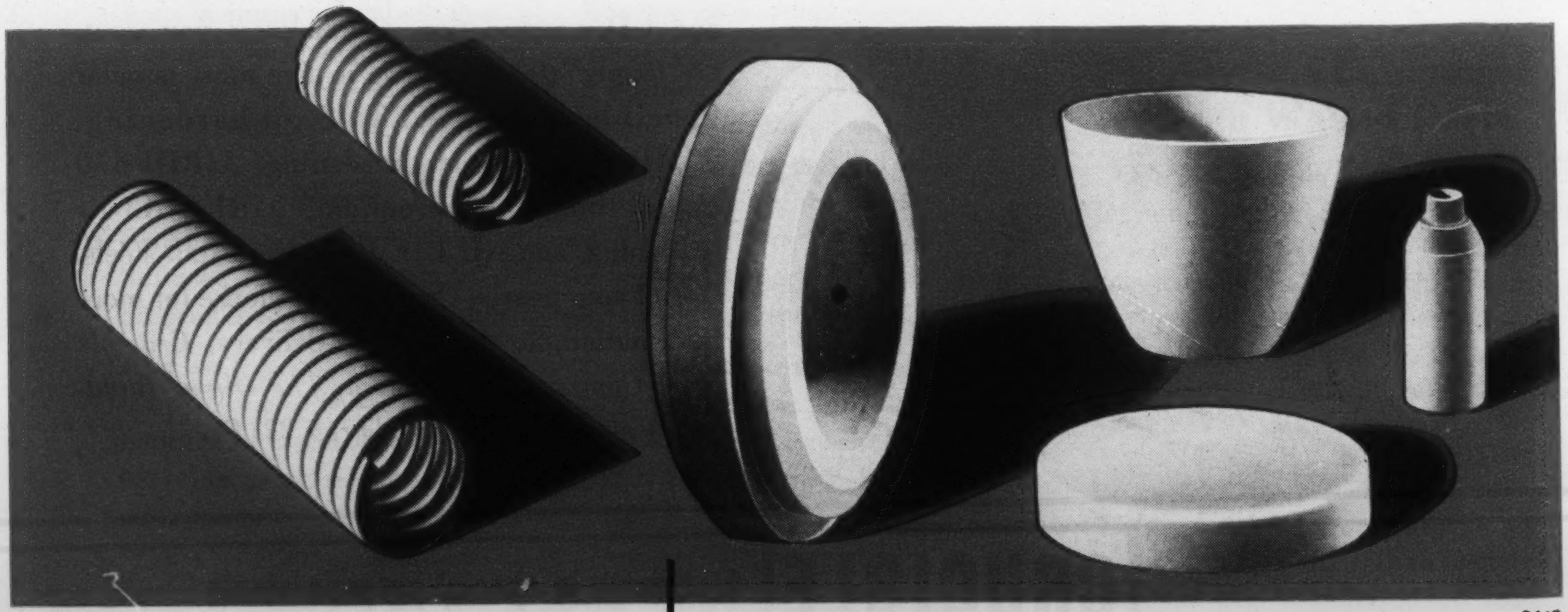
What properties of ALITE will serve you best?

- ***Its diamond-like hardness?***
- ***Its electrical resistivity?***
- ***Its high temperature characteristics?***

Alite is a sintered metallic oxide with decidedly interesting properties. It is so hard, for example, that only a diamond can scratch it. It maintains excellent dielectric properties from power frequencies throughout the entire spectrum into the super high frequency range. It retains its high mechanical strength at temperatures even beyond 2000°F. In its resistance to chemical attack it is comparable to fine quality chemical porcelain.

How is it used? In such mechanical applications as rotating seals, pump plungers, slide valves, cutting tools, sleeve bearings, bushings, extrusion dies. In electronic applications as tube envelopes, as insulating supports. It can be joined to itself or to unrelated materials with a vacuum type bond.

Certainly, any engineer concerned with material specification in mechanical, electronic, or nucleonic design problems should be thoroughly familiar with Alite and its possibilities. Bulletin A-7 tells the story. It is free on request. Write for it today.



266E

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PROPERTIES OF SMD 3700

Tensile Strength, psi	6100
Flexural Strength, psi	10,700
Flexural Modulus, psi	450,000
Notched Izod Impact Strength, ft lb/in.	0.037
Heat Distortion Temperature (264 psi), F	167
Water Absorption (24 hr), %	0.05
Rockwell L Hardness	103
Permeability (760 mm pressure), cu cm/100 sq in./24 hr	
Dry Air	12.4
Dry Oxygen	32.0
Dry Nitrogen	4.9

same techniques that are used for other polystyrenes. Because of its nontoxic nature, it can be used in contact with food.

The chemical resistance characteristics of SMD-3700, when compared with general purpose polystyrenes, appears to be similar, but SMD-3700 is 10 to 15% less permeable to gases and water vapor than other polystyrenes.

New Fibers from Isotactic Polymers?

The new so-called isotactic polymers have molecular characteristics that make them well suited for use as fibers. The essential requirement for a fiber material is that it be capable of producing a very fine filament which combines strength and flexibility. To do this the material must consist of long-chain molecules which are more or less oriented along the axis of the fiber. Also, forces must exist between the individual molecules to 1) stop them from slipping and allowing the fiber to break, and 2) keep them in an oriented arrangement.

J. W. S. Hearle, of the College of Technology, Manchester, described the nature of isotactic polymers and pointed out their suitability for fibers in the Dec '56 issue of *Research* (British). The materials he discussed are those developed by G. Natta of Italy, and include isotactic poly-

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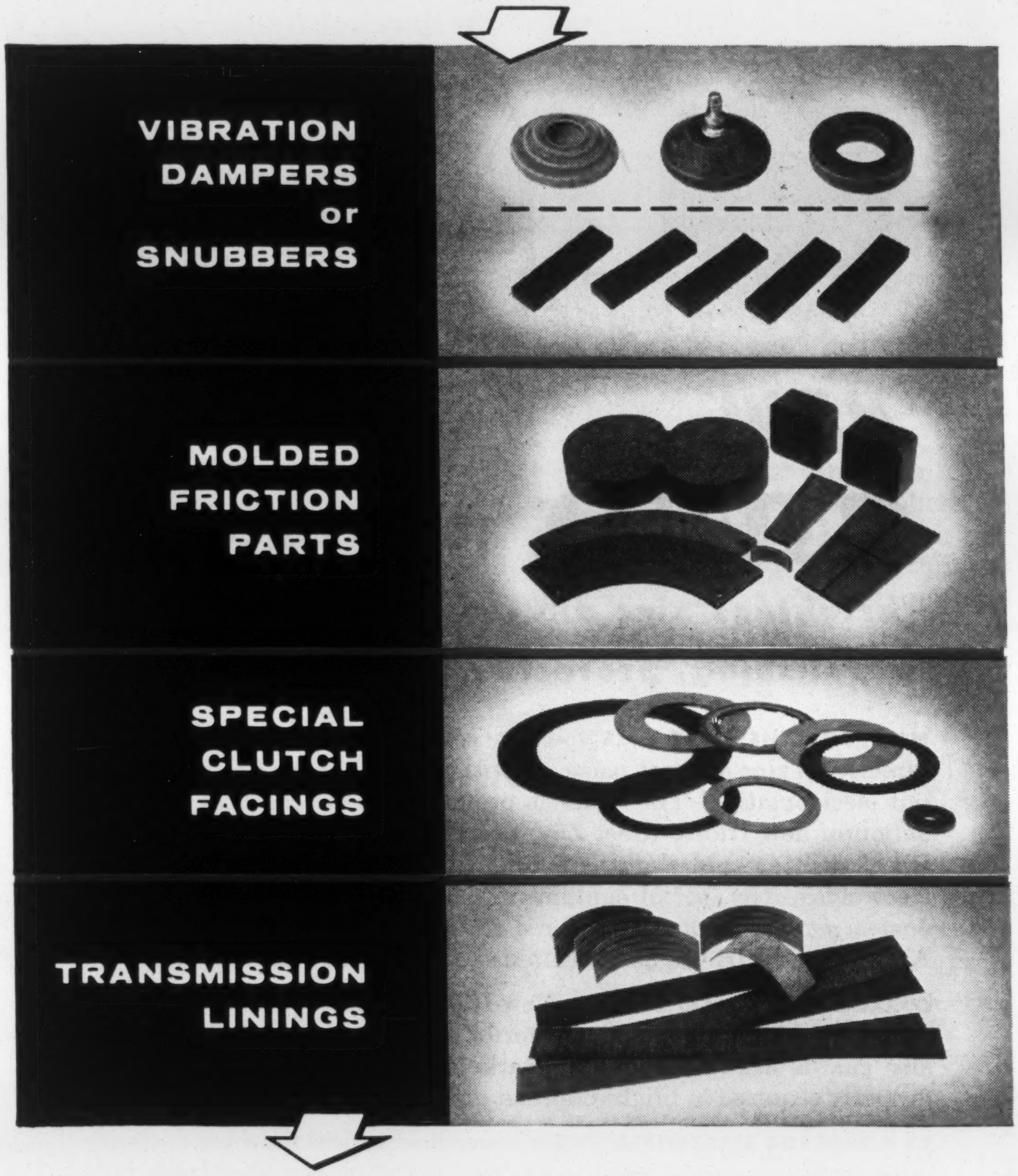

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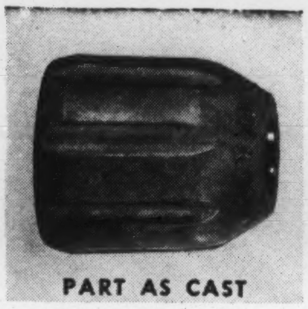
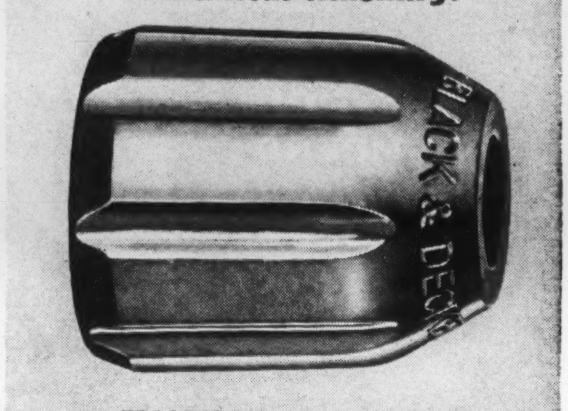
now you can get this brilliant finish directly on zinc die castings!

No electroplating--no mechanical finishing!



PART AS CAST



TREATED WITH NEW IRIDITE

NEW IRIDITE® (Cast-Zinc-Brite)

brightens zinc die castings by chemical polishing, protects against corrosion

NOW, FOR THE FIRST TIME you can get a brilliant, decorative finish directly on zinc die-cast parts . . . without mechanical finishing, without electroplating! The luster is provided by the *chemical polishing* action of new Iridite (Cast-Zinc-Brite) solution. Even surface blemishes, such as cold shuts, are brightened by this new process. No electrolysis. No special equipment. No specially trained personnel. Just a simple chemical dip for a few seconds and the job is done. And, this new Iridite has been *tested and proved* in production.

CORROSION RESISTANCE, TOO! New Iridite (Cast-Zinc-Brite) provides exceptional corrosion resistance for bright-type chromate finishes . . . also guards against blueing or darkening by eliminating zinc plate formerly required in bright chromate finishing of zinc die castings.

AS A BASE FOR ELECTROPLATING—Lower mechanical finishing costs are possible where plated finishes are *required* since the brightness provided by this new Iridite may be sufficient.

LET US SHOW YOU what Iridite (Cast-Zinc-Brite) can do for you. Send us at least a half-dozen typical zinc die-cast parts for FREE PROCESSING for your own tests and evaluation. Or, for immediate information, call in your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified 'phone book. *IMPORTANT: when you give us samples for test processing, please be sure to identify the alloy used.*

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COMPARATIVE PROPERTIES OF FIBER

Material	Tenacity, gm/ denier	Breaking Exten- sion, %	Work of Rupture, gm/ denier
Isotactic Polypropylene[a]	9.3	31	1.6
Nylon[b]	5.3	26	0.9
High Tenacity Nylon[b]	7.7	14	0.7

[a] Density: 0.92 gm per mil.
[b] Density: 1.14 gm per mil.

mers produced from propylene, butylene, pentene, butadiene and styrene.

Properties and uses

Too little is known about these materials to make it possible to predict their behavior in detail, but, from the limited data available, several advantages appear to stand out. The potential cost of isotactic fibers is relatively low, since they are all produced from raw materials that are much simpler and cheaper than those used to produce synthetic fibers currently on the market.

The accompanying table compares properties of some polypropylene fibers, drawn in the laboratory by Natta, with those of two types of nylon fibers. Though the higher strength of polypropylene may be advantageous for some applications, the strength of nylon fibers is sufficient for most applications. However, this higher strength might make the material a competitor with nylon for hosiery. (It would make fine filaments easier to handle and could produce stockings more sheer than those currently on the market.)

Polypropylene seems to be more extensible than nylon, though prestressing the fiber might reduce extensibility and would probably increase strength as well. Also, since the work of rupture is high, indicating an extremely tough and impact resistant material, the fiber should be suitable for tires and for heavy duty industrial uses.

The material's high electrical

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With thermal stability up to 420F. Vistex with Teflon eliminates undesirable lateral plastic flow with excellent stability to corrosive gases, liquids and virtually all chemicals at low and high temperatures.

Vistex with Teflon, with tensile strength of 5,000 psi, has very high tear value, will not ravel or fray, has very good cutting properties. Seals with minimum pressure on polished or irregular surfaces.

American's engineering and research staff is prepared to supply you with complete data and product recommendations. Write today on your company letterhead.

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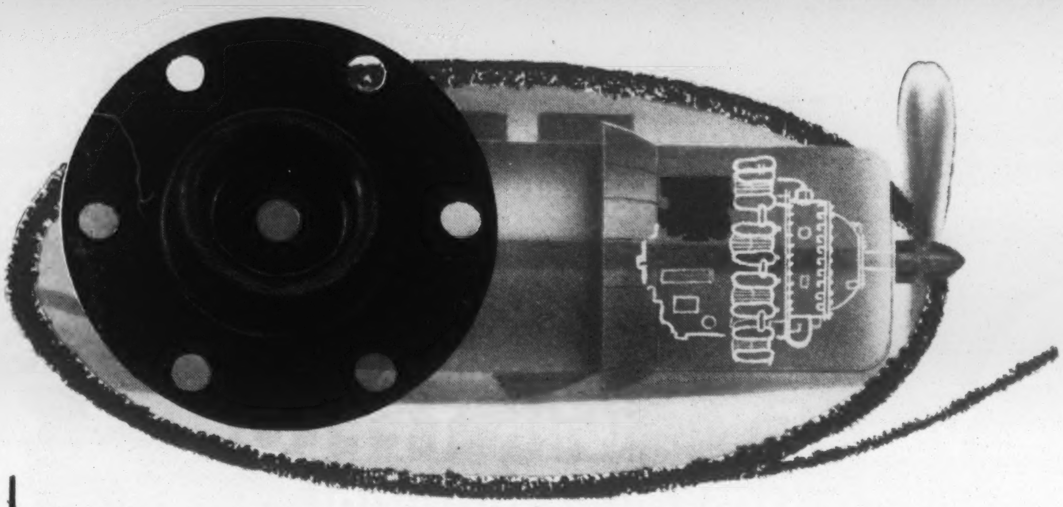
THE SHAPE OF THINGS IN MOLDED RUBBER

MOLDED RUBBER & NYLON FABRIC INCREASES LIFE OF CARBURETOR DIAPHRAGM



APPLICATION:
Aircraft carburetor diaphragm molded for a nationally known aviation firm.

PROBLEM:
Nylon from customer's approved suppliers would not mold, therefore, holding up further development on diaphragm.

SOLUTION:
Acushnet chemists tested many types of nylon fabrics and in co-operation with the nylon supplier, used the results as a guide for a new fabric specification. New techniques were developed by the Acushnet laboratories to prevent pleating of the nylon. A special Acushnet compound molded to one side of the nylon proved successful in resisting the specified iso-octane and aromatic fuels. All dimensions were held to ± .003" without increasing the rejection rate. To further insure its life span, the bolt flange was molded of double coated neoprene on cotton which provided for greater strength and tear resistance.

Let Acushnet be responsible for producing your next molded rubber diaphragm. The complete facilities for creating special compounds and working with new fabrics assure precision diaphragms of all types and sizes.

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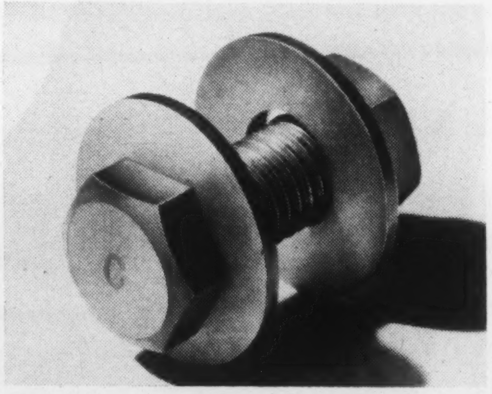
What's new IN MATERIALS

resistance could be useful for insulation applications, but it would be a nuisance in fiber processing because of retention of static charges. The material should be quite resistant to deterioration on exposure to air, light, water and microbiological organisms.

Polypropylene has some disadvantages: it has a softening point of only about 320 F, and it is difficult to dye.

What is 'isotactic'?

Isotactic refers to the geometric arrangement of side groups on individual chains of long-chain molecules. For example, a polystyrene molecule consists of a long chain of carbon atoms with a bulky (benzene) ring of six carbon atoms attached to every alternate carbon atom. Small hydrogen atoms complete the molecule. In conventional polystyrene, the bulky side-groups stick out at random in different directions around the chain. In isotactic polystyrene molecules these side-groups spiral



Low temperature fasteners—Silicon bronze fasteners measuring ½ in. in dia and 1½ in. in length are being used to fasten sections of plastics radar domes set up in the Arctic Circle. Produced by Cleveland Cap Screw Co., 4500 screws, nuts and washers go into the assembly of one radar dome. The silicon bronze material was selected because of its resistance to corrosion and subzero temperatures, the ease with which it can be assembled under unfavorable weather conditions, and its strength (imparted through cold heading).

HIDDEN flaws in *your* products need detecting?

Every day brings new inspection problems to Picker for possible solution. More often than not, radiography (or fluoroscopy) can help. *Here's a typical week's score . . .*

PROBLEM	SOLVED
glass splinters in some candy bars	✓
solder invasion of a precision resistor	✓
bubbles in glass containers	✗ difficult
poor bond in ceramic insulators	✓
failures in adhesives	✓
knives in crude rubber "biscuits"	maybe
stringers in a highly-stressed lock nut	✓
clearances in a miniaturized amplifier	✓
solder tinning on a thin connecting lug	no ✗
porosities in a new type of false tooth	✓
welds in bandsaw blades	✓

Makes no difference *what* you make or buy or sell . . . if it needs "seeing into" for quality control, radiography (gamma or x-ray) can probably profit you.

Talk it over with your local Picker representative * or write us outlining your problem and, if possible, sending typical samples. We'll make tests and tell you frankly whether radiography holds any promise for you. ***Costs you nothing to find out . . . maybe it's costing you a great deal right now NOT TO.***

** There's probably a Picker district office near you (see local 'phone book).*

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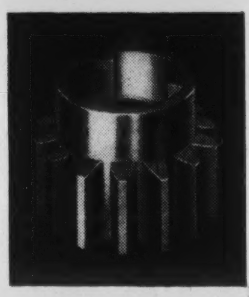

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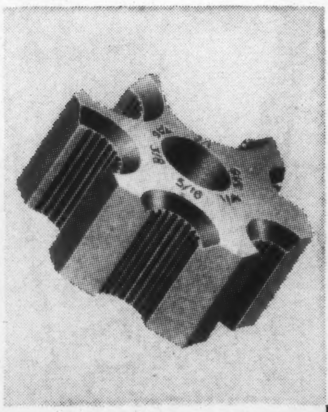
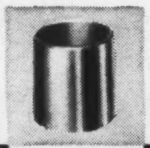
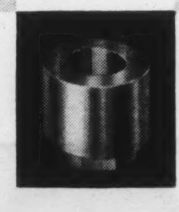
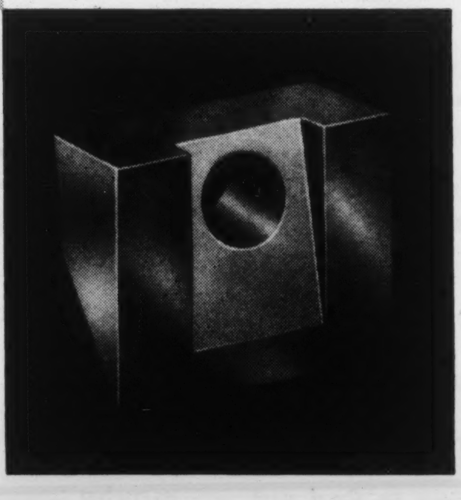
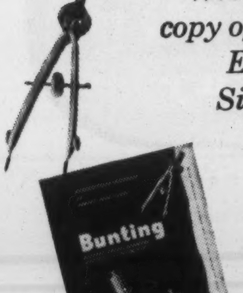

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regularly round the main chain, each one being displaced 120 deg from its neighbor to form a symmetrical molecule.

Many of the physical properties of polymers, such as density, are determined by the arrangement of the long-chain molecule. When side groups are bulky and arranged at random, the molecules can not be as closely packed together as they can when the side groups are regularly arranged as in isotactic polymers.

In practice, many polymer materials consist of a mixture of regularly ordered crystalline regions and less ordered or amorphous regions. The crystalline regions provide the structure with rigidity, hardness and stability; the amorphous areas provide flexibility and they break up more easily, allowing the material to melt. The tendency to form a crystalline structure is increased when the forces of attraction between molecules are strong, and when the molecules can pack closely together so that the forces between them can exert a greater effect. Thus isotactic polymers in general, have a higher degree of rigidity, hardness and stability than non-isotactic materials.

New Magnetic Alloy Aids Miniaturization

With the development by Bell Telephone Laboratories of a new magnetic alloy, substantial improvements are now possible in magnetic amplifiers, switching and memory devices, and pulse and power transformers. Called

PROPERTIES OF SUPERMENDUR

Maximum Permeability	66,000 at 20,000 gausses
Remanence	21,500 gausses
Coercive Force	20.26 oersteds
Saturation	4,000 gausses
Core Losses	Less than 6 w/hr at 400 cps at a flux density of 100,000 lines/sq in.

For more information, Circle No. 640 ➤

Supermendur, the alloy is said to have higher permeability and lower hysteresis losses at higher flux densities than any material previously available.

The alloy—49 iron, 49 cobalt, and 2% vanadium—is produced in a controlled atmosphere furnace. After melting, the alloy is subjected to a prescribed schedule of rolling and heat treatment in a magnetic field. The material is claimed to be so malleable that it can be cold rolled from 0.090 in. to 0.0003 in. without intermediate anneals and without losing ductility.

Power transformer cores of 0.004 or 0.002-in. Supermendur tape can provide an output more than 30% greater than comparable grain-oriented silicon steel cores (the best previously available material). As a result core size and weight can be reduced as much as 30% for the same output. This makes the material especially suitable for applications where miniaturization is desired.

Hardwood Laminate for Table Tops, Dies

A hardwood laminate, called Benelex 30, has been introduced by Masonite Corp., 111 W. Washington St., Chicago 2, Ill., for use as jigs, fixtures, dies, patterns, templates, table tops and forms. Bonded together with resorcinol adhesives, the hardwood laminates are easy to shape, saw, drill and paint. They are available in thicknesses ranging from 3/8 to 1 1/4 in.

Polyurethane Foam Is Fast Curing

Chase Chemical Corp., 3527 Smallman St., Pittsburgh 1, Pa., has developed a two-component polyurethane foam system that cures without the use of external heat or pressure. According to the

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STAY OUT OF TROUBLE WITH A FORGING!

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The part illustrated above *will* become a component of the complete product — will *not* become a reject — BECAUSE IT IS A FORGING

You get effective machinability because forgings are dense, homogenou metal, free of porosity and other flaws. Forgings start with *forging qualit metal* which is improved by the forging process. This fact also offers advan tages in heat treating and welding.

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Reduce your cost by using forgings. Send for booklets, ☐ "What is a Forging?" and ☐ "Management Guide to the Use of Forgings."

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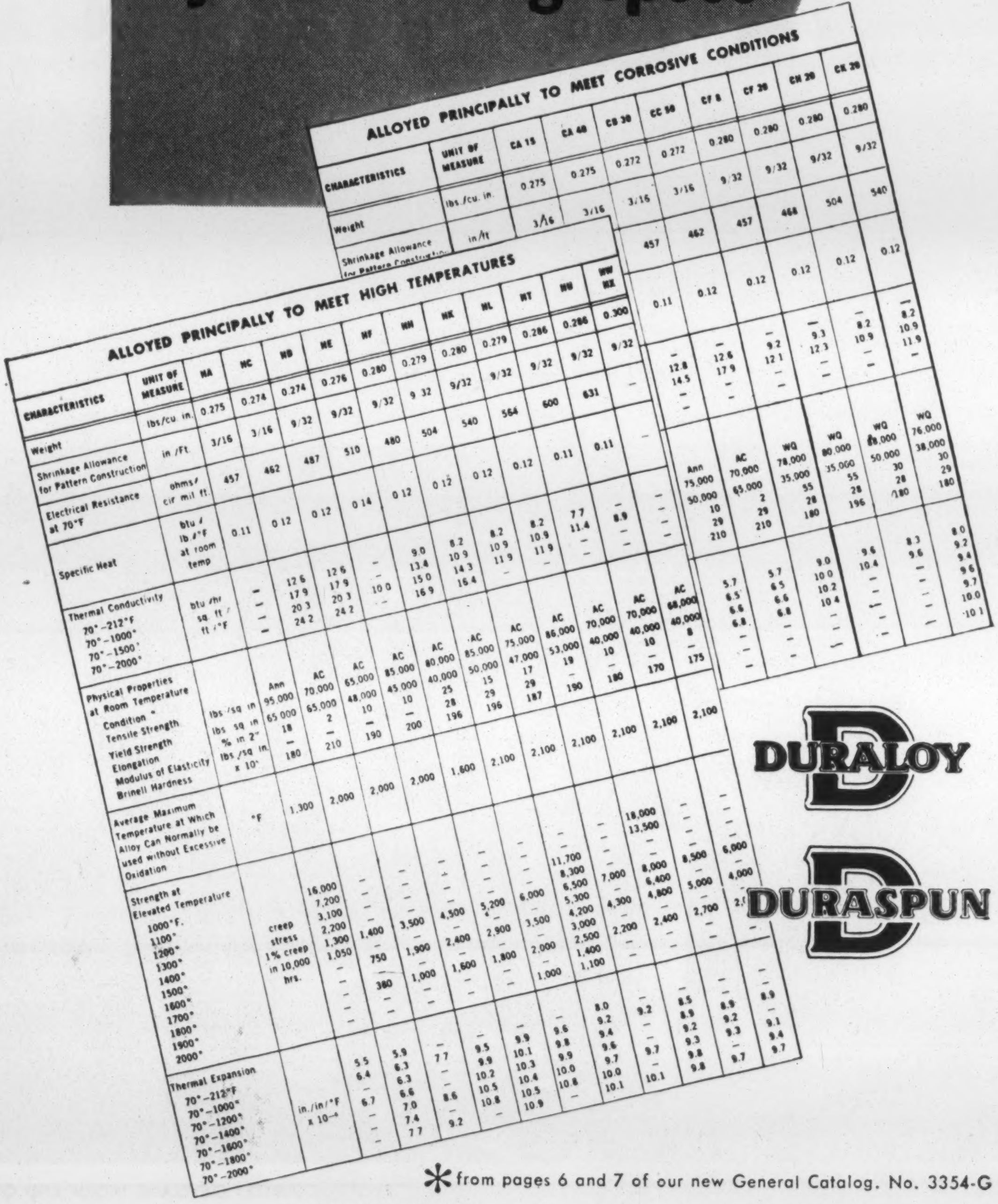
* TABLES to help you select the proper alloy for your casting specs



ALLOYED PRINCIPALLY TO MEET CORROSIVE CONDITIONS

CHARACTERISTICS	UNIT OF MEASURE	CA 15	CA 40	CB 30	CC 50	CF 8	CF 20	CH 20	CK 20
Weight	lbs./cu. in.	0.275	0.275	0.272	0.272	0.280	0.280	0.280	0.280
Shrinkage Allowance for Pattern Constru	in/ft	3/16	3/16	3/16	3/16	9/32	9/32	9/32	9/32
				457	462	457	468	504	540
				0.11	0.12	0.12	0.12	0.12	0.12
				— 12.8 14.5 — —	— 12.6 17.9 — —	— 9.2 12.1 — —	— 9.3 12.3 — —	— 8.2 10.9 — —	— 8.2 10.9 11.9 —
				Ann 75,000 50,000 10 29 210	AC 70,000 65,000 2 29 210	WQ 78,000 35,000 55 28 180	WQ 80,000 35,000 55 28 196	WQ 88,000 50,000 30 28 180	WQ 76,000 38,000 30 29 180
				5.7 6.5 6.6 6.8 — — —	5.7 6.5 6.6 6.8 — — —	9.0 10.0 10.2 10.4 — — —	9.6 10.4 — — — — —	8.3 9.6 — — — — —	8.0 9.2 9.4 9.6 9.7 10.0 10.1

ALLOYED PRINCIPALLY TO MEET HIGH TEMPERATURES

CHARACTERISTICS	UNIT OF MEASURE	HA	HC	HD	HE	HF	HH	HK	HL	HT	HU	HW HX
Weight	lbs/cu. in.	0.275	0.274	0.274	0.276	0.280	0.279	0.280	0.279	0.286	0.286	0.300
Shrinkage Allowance for Pattern Construction	in /Ft.	3/16	3/16	9/32	9/32	9/32	9 32	9/32	9/32	9/32	9/32	9/32
Electrical Resistance at 70°F	ohms/cir mil ft.	457	462	487	510	480	504	540	564	600	631	—
Specific Heat	btu/lb/°F at room temp	0.11	0.12	0.12	0.14	0.12	0.12	0.12	0.12	0.11	0.11	—
Thermal Conductivity 70°–212°F 70°–1000° 70°–1500° 70°–2000°	btu/hr/sq. ft/ft/°F	— — — —	12.6 17.9 20.3 24.2	12.6 17.9 20.3 24.2	— — 10.0 —	9.0 13.4 15.0 16.9	8.2 10.9 14.3 16.4	8.2 10.9 11.9 —	8.2 10.9 11.9 —	7.7 11.4 — —	— 8.9 — —	— — — —
Physical Properties at Room Temperature Condition * Tensile Strength Yield Strength Elongation Modulus of Elasticity Brinell Hardness	lbs/sq in lbs sq in % in 2" lbs/sq in. $\times 10^{6}$	Ann 95,000 65,000 18 — 180	AC 70,000 65,000 2 — 210	AC 65,000 48,000 10 — 190	AC 85,000 45,000 10 — 200	AC 80,000 40,000 25 28 196	AC 85,000 50,000 15 29 196	AC 75,000 47,000 17 29 187	AC 86,000 53,000 19 — 190	AC 70,000 40,000 10 — 180	AC 70,000 40,000 10 — 170	AC 68,000 40,000 8 — 175
Average Maximum Temperature at Which Alloy Can Normally be used without Excessive Oxidation	°F	1,300	2,000	2,000	2,000	1,600	2,100	2,100	2,100	2,100	2,100	2,100
Strength at Elevated Temperature 1000°F. 1100° 1200° 1300° 1400° 1500° 1600° 1700° 1800° 1900° 2000°	creep stress 1% creep in 10,000 hrs.	16,000 7,200 3,100 2,200 1,300 1,050 — — — — —	— — — — 1,400 — 750 — 380 — —	— — — — 3,500 — 1,900 — 1,000 — —	— — — — 4,500 — 2,400 — 1,600 — —	— — — — 5,200 — 2,900 — 1,800 — —	— — — — 6,000 — 3,500 — 2,000 — 1,000	— — 11,700 8,300 6,500 5,300 4,200 3,000 2,500 1,400 1,100	— — — — 7,000 — 4,300 — 2,200 — —	18,000 13,500 — — 8,000 6,400 4,800 — 2,400 — —	— — — — 8,500 — 5,000 — 2,700 — —	— — — — 6,000 — 4,000 — 2,[illegible] —
Thermal Expansion 70°–212°F 70°–1000° 70°–1200° 70°–1400° 70°–1600° 70°–1800° 70°–2000°	in./in/°F $\times 10^{-6}$	5.5 6.4 — 6.7 — — —	5.9 6.3 6.3 6.6 7.0 7.4 7.7	— 7.7 — — 8.6 — 9.2	— 9.5 9.9 10.2 10.5 10.8 —	— 9.9 10.1 10.3 10.4 10.5 10.9	— 9.6 9.8 9.9 10.0 10.8 —	8.0 9.2 9.4 9.6 9.7 10.0 10.1	— 9.2 — — 9.7 — 10.1	— 8.5 8.9 9.2 9.3 9.8 9.8	— — 8.9 9.2 9.3 — 9.7	— — 8.9 — 9.1 9.4 9.7

DURALOY

DURASPUN

* from pages 6 and 7 of our new General Catalog. No. 3354-G

— and there's lots more useful information about high alloy castings in our up-to-date catalog describing Duraloy Service. SEND FOR YOUR COPY.

As one of the pioneers in both static (1922) and centrifugal (1931) high alloy castings, we have a wealth of experience to focus on your high alloy casting problem. Send for our catalog, study it, and then let us help you get the best alloying combination to solve your corrosion, high temperature and/or abrasion problem.

THE DURALOY COMPANY
OFFICE AND PLANT: Scottdale, Pa.
EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.
CHICAGO OFFICE: 332 South Michigan Avenue

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company, a 2 lb-per-cu-ft block of foam will set in 5 min and cure in 10 min at room temperatures by using Nafil AR Resin and Nafil HM Catalyst. The quick curing properties of the two component system are said to make it an ideal material for molding or casting on a production line.

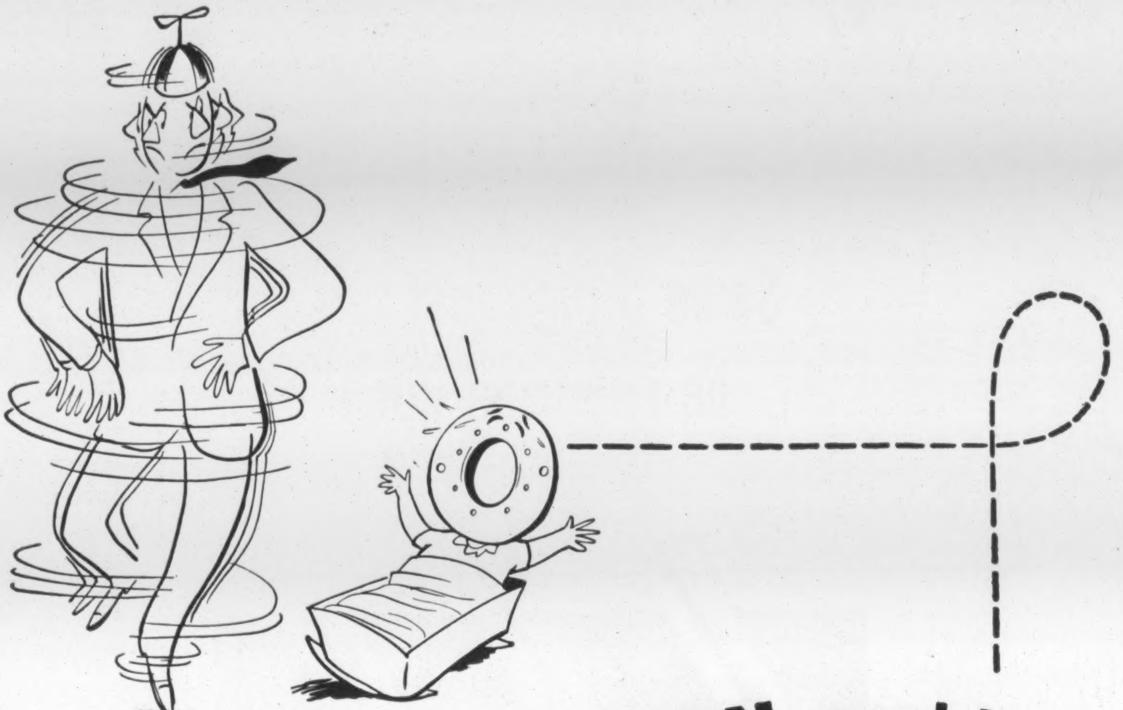
It is claimed that the new system produces an extremely tough material that can be handled, coated and packaged 10 min after mold removal without rupturing the cells or deforming the foam. The cured foam is recommended for insulation, structural reinforcement, sound deadening, potting and void filling.

Stainless Steel Pipe Has High Strength

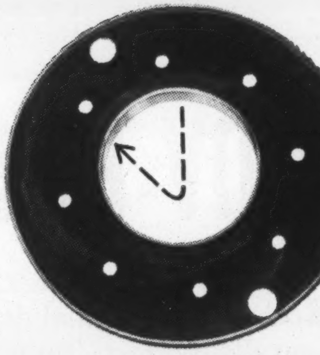
Finished lengths of tubing and pipe, up to 20 ft, 6 in. in length, are now available in two corrosion resistant stainless steel grades from Carpenter Steel Co., Alloy Tube Div., Union, N. J. The stainless steels are called Alloys B and C. Alloy B is a nickel-molybdenum-iron alloy that is said to resist concentrated hydrochloric acid at all temperatures, boiling sulfuric acid, phosphoric acid and wet hydrogen chloride gas.

Alloy C is a nickel-molybdenum-chromium-iron alloy that resists aqueous solutions of halogen salts, nitric acid, acid solutions of ferric and cupric salts, and acetic, formic, sulfurous, hydrochloric and phosphoric acids.

Carpenter is also supplying tubing and pipe made of a precipitation hardenable chromium-nickel steel called Alloy 17-7PH. The steel is recommended for parts requiring abrasion resistance and high tensile strength. In the hardened condition (TH 1050) the steel is said to have higher mechanical properties than any of the chromium-nickel stainless steels. Tensile strength of



a FRETTING-CORROSION problem had him in a spin



Finding a wear-resistant coating for turbine engine shaft seals posed a serious problem for an aircraft engine manufacturer. Even the hardest alloys were subject to fretting corrosion and had to be replaced after a few hours of service.

This fretting-corrosion problem was solved by having the bearing surface of the seal Flame-Plated by LINDE. By this special detonation process, particles of tungsten carbide are literally *blasted* onto almost any metal surface. Most important, the temperature of the part being plated never exceeds 400° F., so there is little chance that the base metal will warp or that its metallurgical properties will be changed. Flame-Plated tungsten carbide coatings can be applied in thicknesses from .010 to .002 inches. Coatings can be used in the as-coated condition (125 microinches rms) or ground and lapped to a 0.5 microinch finish.

If your design involves metal parts subject to extreme wear, heat, or fretting corrosion, perhaps Flame-Plating can eliminate some or all of your "headaches"—or make possible some completely new idea.

To find out, write us about your wear problem or request a free copy of LINDE's booklet, "Flame-Plating," F8065. Address Flame-Plating Department.

Flame-Plating
by Linde

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Some things just can't be improved upon

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GROOV-PIN'S ORIGINAL DESIGN

Because the original design of the Groov-Pin was fundamentally perfect, they have been in use, in essentially their present form, for more than a quarter of a century. A large number of prominent American manufacturers have taken advantage of the opportunities they afford for substantial savings in manufacturing and maintenance costs, design simplification and customer satisfaction.

The Groov-Pin is a cylindrical metal pin (usually cold-rolled steel) cut from bar or coil stock. Longitudinal grooves are rolled or pressed into the body to deform the stock within controlled limits, When the Groov-Pin is forced into a hole of correct diameter, the constraining action of the wall causes the displaced material to flow back and make a locking fit within its elastic range.

Groov-Pins are assembled in straight drilled holes. No tapping, reaming, peening or milling are required. They can be driven by hand hammer, air cylinder or hydraulic press.

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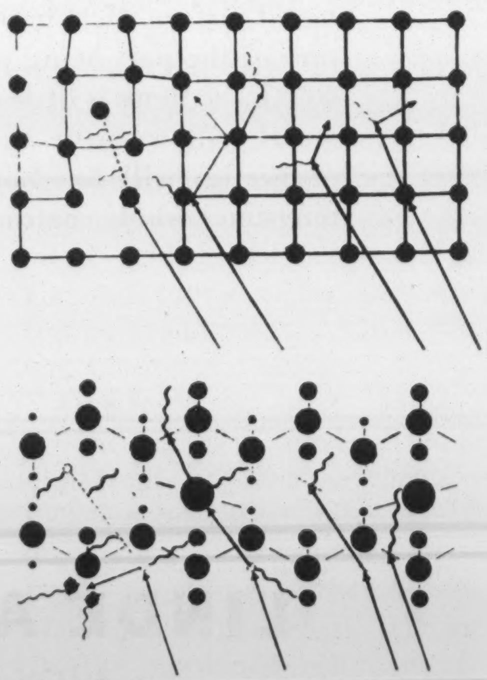
the hardened steel is 200,000 psi and yield strength is between 180,000 and 190,000 psi. Annealed tubing and pipe made from this alloy are readily bent, formed, drawn, welded, brazed and machined. All tubular forms of Alloy 17-7PH are supplied in the annealed condition.

How to Select and Use Aircraft Materials

Ninety-four technical papers featured the 25th annual meeting of the Institute of Aeronautical Sciences held in New York City a few months ago. A number of papers were concerned with the selection and use of materials for present and future high speed aircraft.

Radiation resistance

Of particular interest was a paper given by Capt. A. J. Mione of Wright Air Development Center on the use of materials in a nuclear environment. Capt. Mione's paper presented data on the effects of nuclear radiation on crystalline and noncrystalline structures. (For more information on select-



***Radiation** has very little effect on metallic crystalline structures (top) as compared with nonmetallic structures (bottom).*

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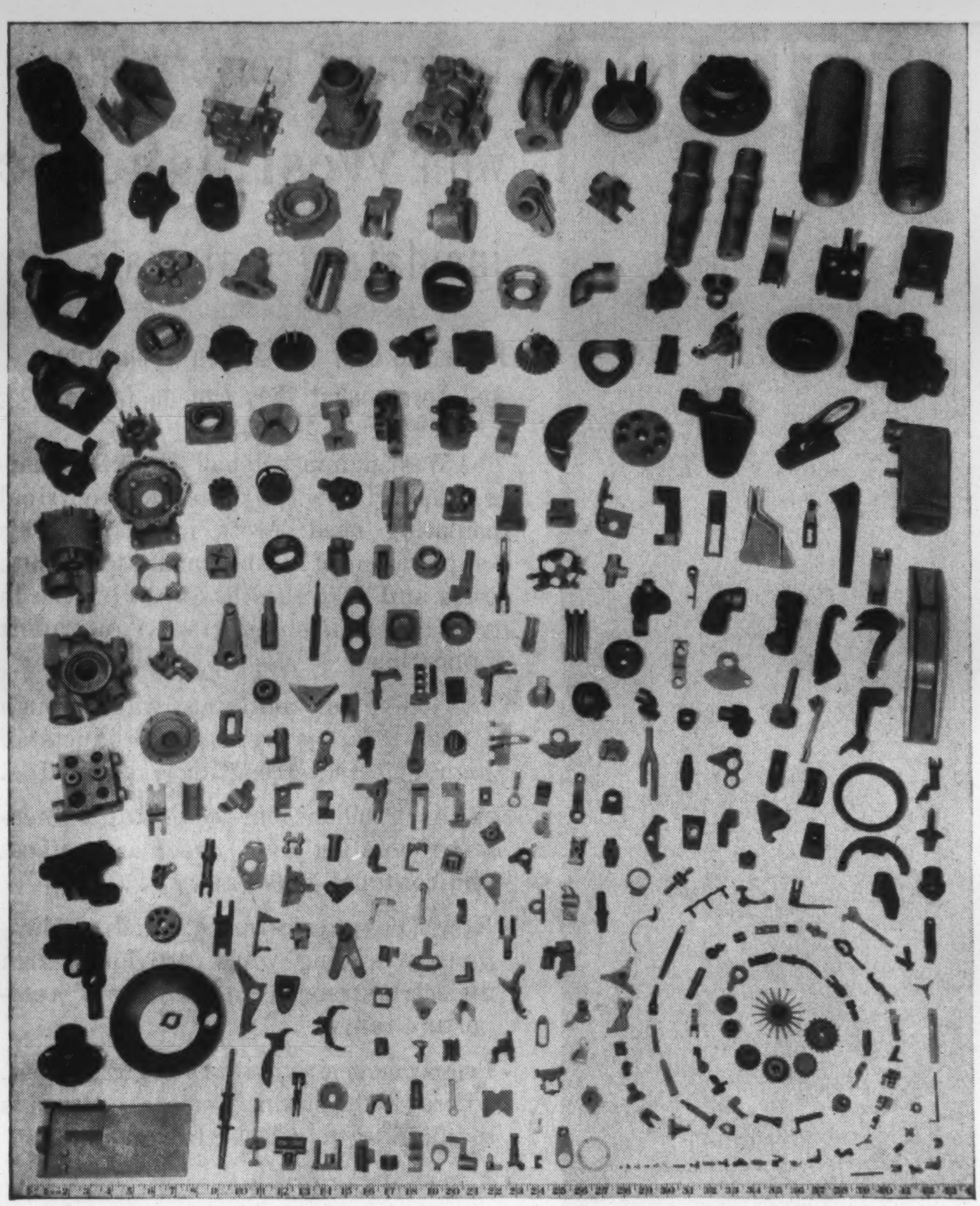

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Precision Metalsmiths makes them all—a million pieces for your production or a few at a time, as you develop a product. Pictured above are some of the investment castings we're making regularly.

Cast to close tolerances and accurate in details, such parts require surprisingly little finishing. Expensive pre-assembly machining is avoided, since complicated parts are produced as single units. We do the assembling with expendable patterns.

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Investment Castings

For more information, turn to Reader Service Card, Circle No. 469

What's new IN MATERIALS

Courtesy Aluminum Co. of America

Multi-jet seaplane, *capable of traveling at speeds of 600 mph, demands highly oil and heat resistant rubber parts for its fuel, hydraulic and lubricating systems.*

ing radiation resistant materials, see M&M, Aug '56, 121).

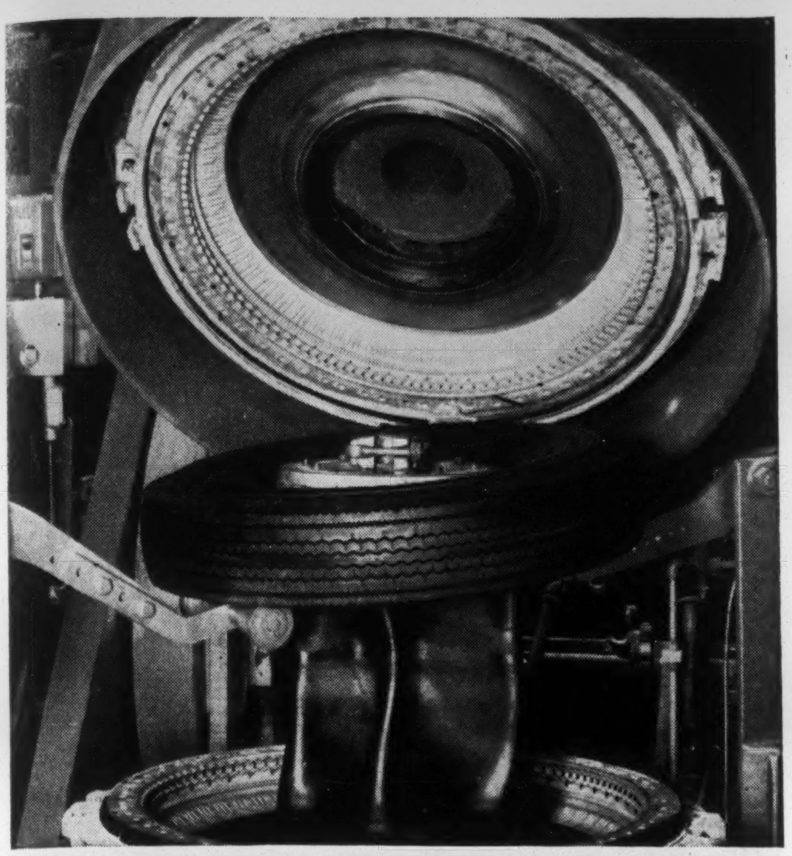
In order to protect the crew of an atomic powered plane, materials must be resistant to beta rays, neutrons and gamma rays, yet must be light enough so that the plane can get off the ground. Since few materials can currently withstand such high levels of radiation, a compromise between shield weight and radiation levels is required in design.

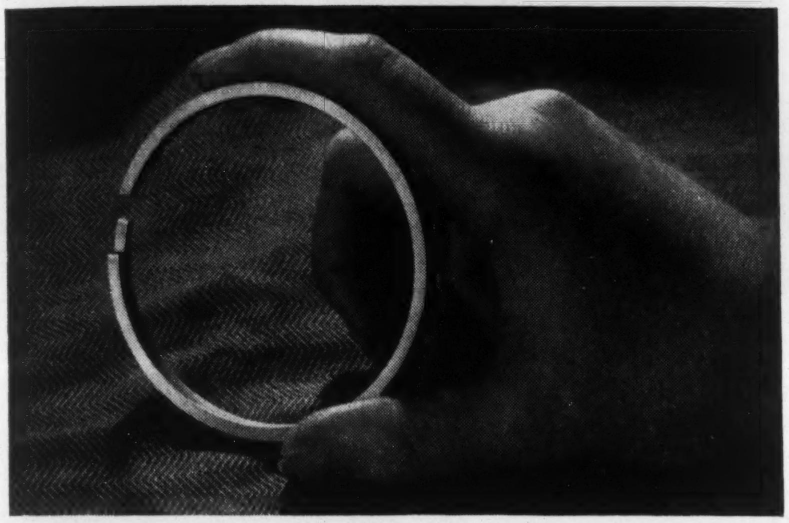
To develop radiation resistant materials, the atomic structures of matter must be considered. For instance, metallic crystalline structures (see drawing) are distinctive in that the bonds that hold the individual atoms together are extremely strong and difficult to rupture. When a metallic structure is exposed to atomic radiation, the only effect noticeable is a moderate amount of heating, the normal result of adding energy to a crystalline system.

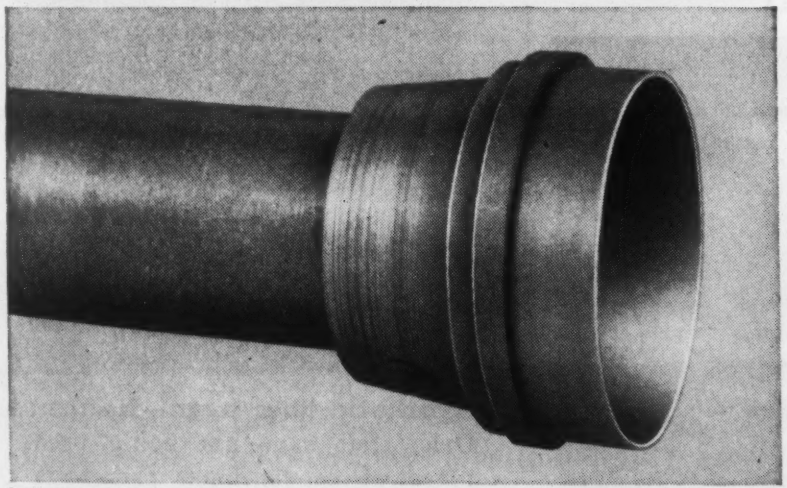
How materials perform

On the other hand, noncrystalline structures, such as rubber, plastics, adhesives, fabrics and electrical insulation, built from the chemistry of carbon and hydrogen, differ radically in crystalline structure from the metals (see drawing). The atoms which bind these materials together can be disrupted by the addition of energy to the system and rupture of the atomic bonds results in a complete change of the molecular structure of the material. Thus,

Where ordinary steel failed---
Part made of Special Armco Stainless Fights Rust and Wear--Lasts Longer







Core of this tire-curing mold is a center cylinder assembly. This unit moves diaphragm and ring, and strips the cured tire from the bottom half-mold as the press opens. With each stroke of the stainless steel piston within the bronze cylinder, the piston ring, made of Armco 17-7 PH Stainless, scrapes the inside of the cylinder free of foreign matter.

Corrosive combinations of steam and sulfur compounds made short work of carbon steel scraper rings previously used in tire-curing presses like this one.

Now, according to the press manufacturer, service life of the scraper ring is "excellent." The reason: Armco 17-7 PH Stainless Steel is now specified.

Here's why rings made of this special precipitation hardening stainless steel last longer.

. . . Resistance of 17-7 PH to wear and corrosion is much greater than that of carbon steel.

. . . 17-7 PH rings are extra hard and tough—resist wear from continual action against cylinder walls.

In addition, ability of this special steel to resist distortion in heat treating helps assure accurate dimensions in this close-fitting part.

Problem-Solving Pair

Armco 17-7 PH and its companion precipitation hardening grade, Armco 17-4 PH, are unique among the stainless steels. Parts can be *finish-fabricated* from these special steels in the annealed condition, then given high strength and hardness by simple heat treatment. 17-7 PH is produced in sheet, strip, plate, bar and wire; 17-4 PH in billets, bar and wire.

For full information about these Armco Precipitation Hardening Stainless Steels, just write us at the address below.

Armco Steel Corporation

1027 Curtis Street, Middletown, Ohio

SHEFFIELD STEEL DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION

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Pre-Plated Metals Offer Design Freedom, Production Savings!

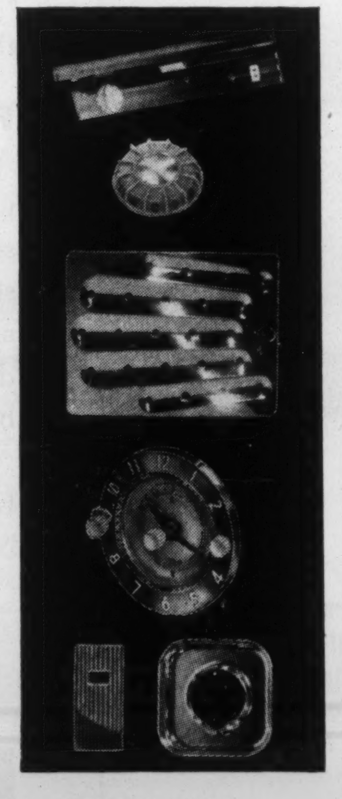
Beautiful, easy-to-clean built-in range by Oakland Foundry, Belleville, Ill., features Nickeloid pre-plated chrome steel, satin finish, for door panels, oven, burner inserts, control panel and hood.

More Than A Metal—It's A Method

Oakland Foundry, Belleville, Ill., a leading manufacturer of electric ranges, puts it this way: "We were unable to fabricate the alternate material without new tooling. Nickeloid Metals have increased our production, reduced rejects and lowered the costs of our product".

If *you* are caught between increasing manufacturing costs and the constant consumer demands for new and improved products, consider Nickeloid *Pre-Finished* Metals. An extremely versatile design material, they fit right in with standard production techniques, without major retooling — lower manufacturing costs and equipment investment because they require no cleaning, post-plating, polishing. You just fabricate and assemble — *and save!*

Choose from beautiful, durable finishes of chrome, nickel, copper or brass on steel, zinc, copper, brass and aluminum. Sheets, strips, coils.



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What's new IN MATERIALS

nuclear reactions cause severe damage to organic structures by essentially changing the chemical nature of the molecules. The effects of nuclear radiation on organic materials are listed below.

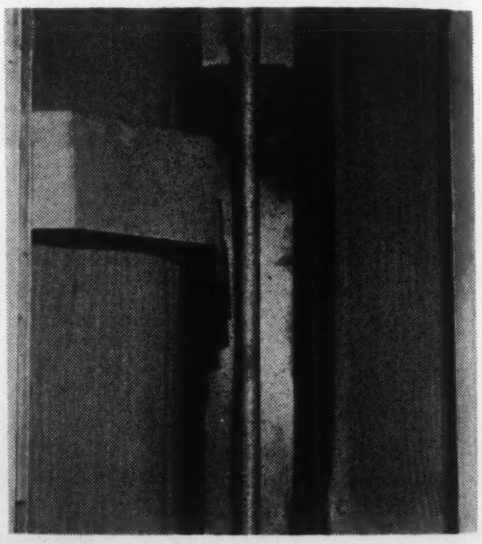
Elastomers: Natural rubber appears to withstand nuclear radiation better than any of the synthetics.

Plastics: Teflon, which is an excellent insulating material and is stable, inert, and fairly temperature resistant, deteriorates very rapidly when exposed to nuclear radiation.

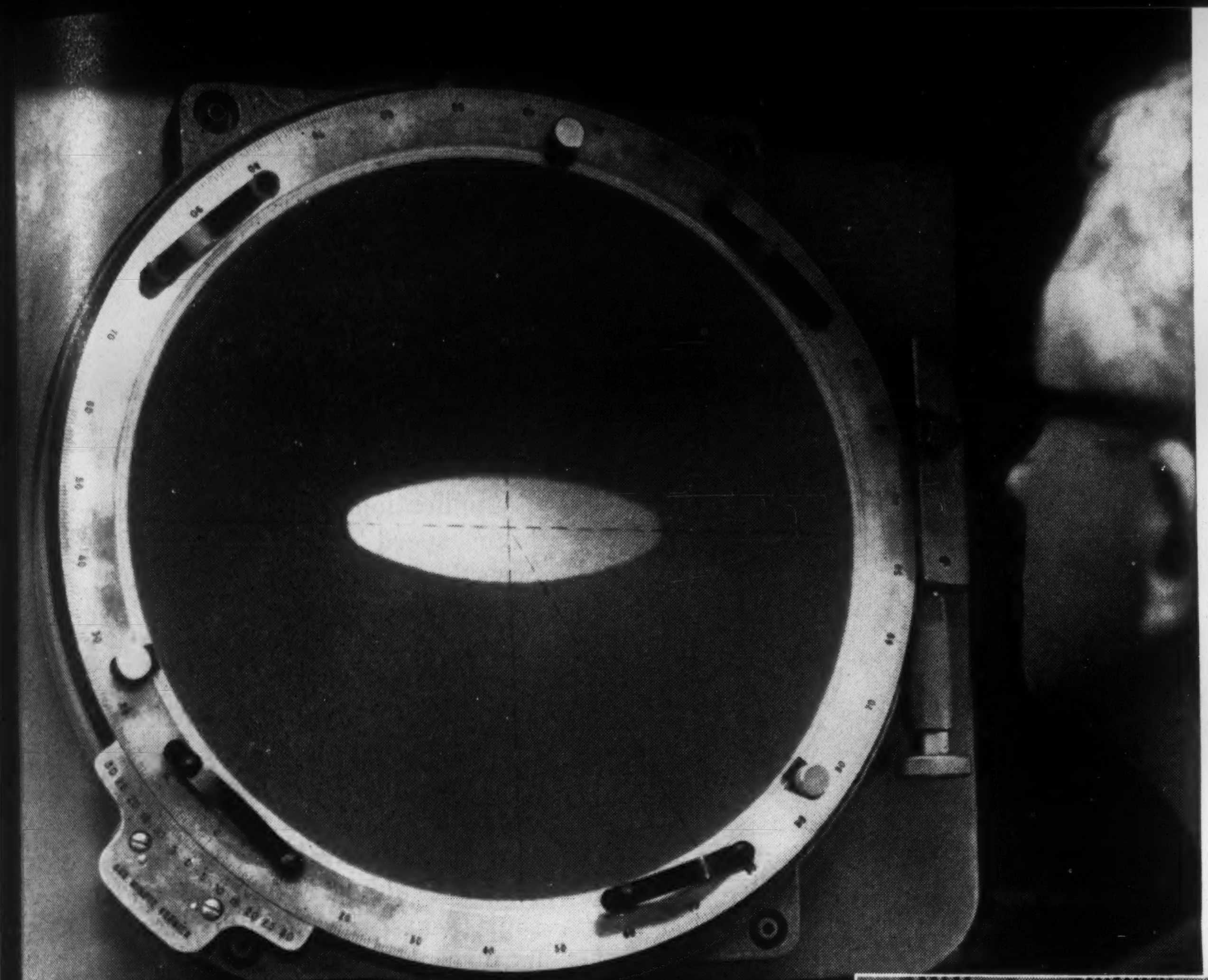
Reinforced Plastics: Glass reinforced phenolic, epoxy and polyester resins show reasonable radiation resistance as a group.

Adhesives: Structural adhesives show fair resistance to radiation.

Synthetic Fabrics: Of the syn-

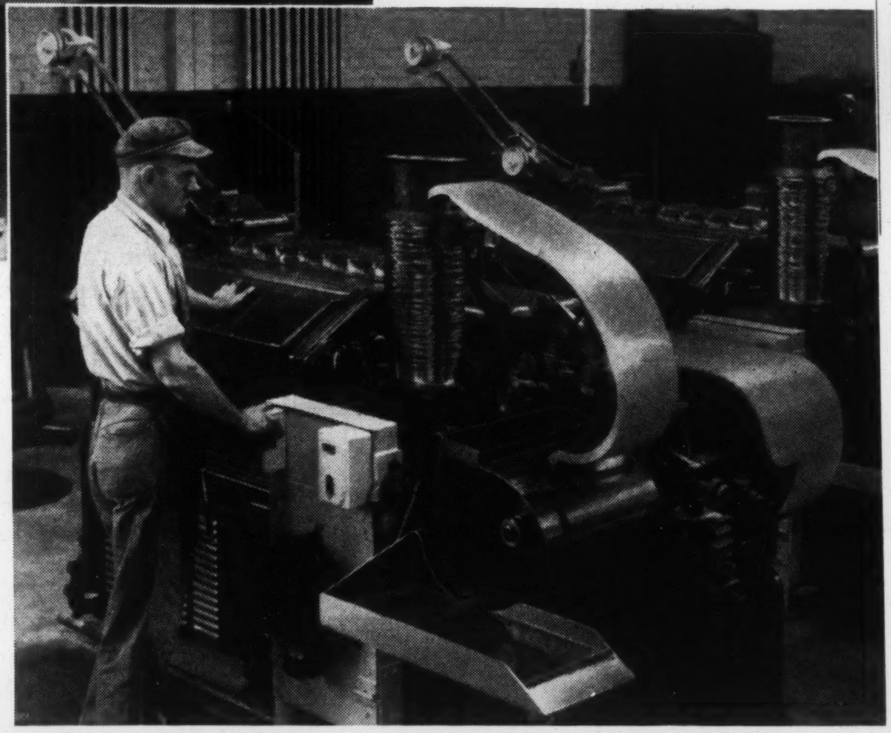


Synthetic fiber bags—Dacron and Orlon felt bags are being used in place of conventional felt bags in taconite dust collecting units. Each unit, containing 12 dust collecting bags, is capable of clearing the atmosphere of about 1000 lb of dust an hour. Taconite dust, formed by crushing huge slabs of iron-bearing rock, is nearly as abrasive as diamond dust. Despite this abrasiveness, the synthetic fiber bags have operated continuously since 1955. In addition, the synthetic bags are said to be dimensionally stable in the presence of moisture and are able to withstand the extremely abrasive conditions of wet taconite dust.



A sample of oval wire is checked for accuracy by an inspector as he studies the image, here magnified 20 times, on an optical comparator.

This battery of continuous, wet-drawing machines is typical of our new facilities for producing fine wire. Note that the machine in the foreground is spooling fine wire as it comes off the block.



Shaped wire and fine wire— Bethlehem specialties

There's nothing "run of the mill" in making shaped and fine wire. That's why we have expanded and re-grouped a special division of our rod and wire mill at Johnstown, Pa. It's our "Fine and Specialty Wire Department," in which we now have a variety of brand-new equipment of the most modern design. It's our latest step towards specializing in the making of fine, flat, and shaped wire.

We're now drawing fine wire to sizes as small as 0.007 in. (40 gage). And we can furnish fine wire with liquor, white-liquor, coppered, and other finishes, including redrawn bethanized—electrolytically coated with 99.9-per-cent pure zinc. We have the equipment to offer fine wire in a wide range of spool sizes. And we have the heat-treating facilities, drawing blocks, and other equipment to provide a wide variety of tempers and physical properties.

We regularly make flat, square, octagon, hexagon, oval and an increasing number of other shapes. Shaped wire offers many advantages to the fabricator. For example, oval wire has more surface than round wire of the same cross-sectional area. This feature, for example, is useful in reinforcement applications where the greater surface area improves cohesion between the material to be reinforced and the steel wire itself.

We've never been in such a good position to offer prompt delivery of shaped and fine wire in production quantities. The nearest Bethlehem sales office will give you the details. And you can be sure that our people in the mill, as well as in the sales office, will work with you all the way.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

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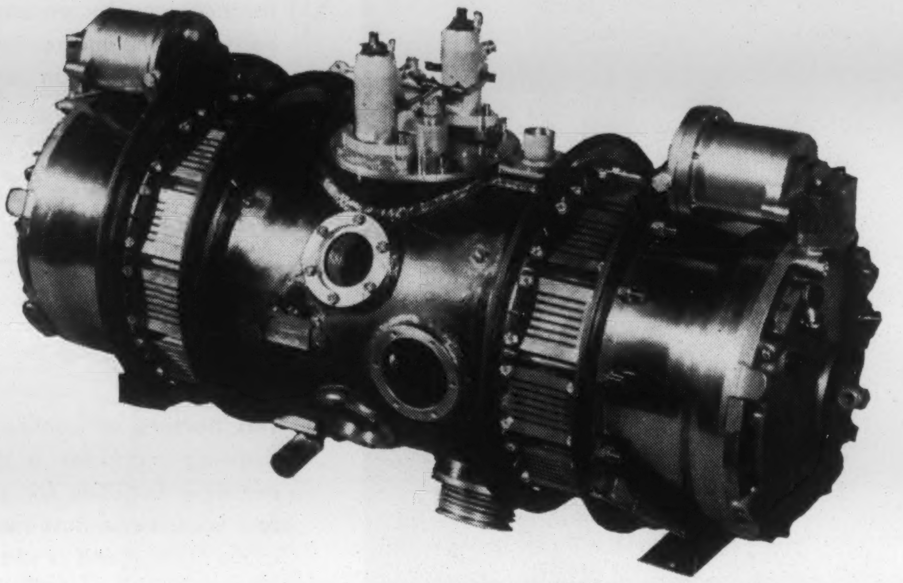
Looking ahead with FORD and PORUS - KROME



FORD'S experimental free piston gassifier has PORUS - KROME plated cylinder bores . . . . . in engine and compressors.

TOMORROW'S automotive power may be here today in Ford's free piston gassifier.

That's Design Engineering's job . . . to look and plan ahead . . . to build Now for the future.

When Ford engineers were designing this gassifier, excessive piston speed and attendant friction dictated the selection of the most wear resistant material on the cylinder bores -- to withstand punishing abuse.

That's where Van der Horst entered the picture.

Van der Horst Corporation's extensive plating know-how, quality craftsmanship and their patented Porus - Krome process for plating porous chromium made the company first choice.

This is another example of Van der Horst's engineered plating services -- designed to solve problems involving wear, corrosion and abrasion.

What is PORUS - KROME? Porus-Krome is to chromium as stainless steel is to steel -- a processed improvement of a basic material specifically designed to meet the demands of a special application. Porus-Krome has ALL the superior physicals of chromium PLUS an affinity for lubricants.

For more detailed information on PORUS-KROME, write Van der Horst Corporation, 1666 East St., Olean, New York.

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LOS ANGELES, CALIFORNIA*
CHICAGO, ILLINOIS
HILVERSUM, HOLLAND

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thetic fabrics, Dacron appears to be the most resistant to radiation.

Elastomers for aircraft

Applications for elastomers in high speed aircraft were discussed by Captain Martin H. Brewer of the Air Research and Development Command. Capt. Brewer stressed the need of new polymers for use in aircraft fuel, lubricating and hydraulic systems. For example, high energy fuels used in high speed aircraft cause commercially available elastomers to swell almost immediately. In some cases the amount of swell may reach 100% within 24 hr.

Rocket fuels

Solid and liquid rocket propellants which are used in high speed, high altitude missiles are extremely detrimental to most organic materials, including elastomers. Most elastomers are severely degraded by many of these liquids in a very short time. Moreover, other potential fuels, such as fluorine, liquid oxygen and hydrogen, create even more difficult problems due to the corrosive nature of the fuels and the extreme low temperatures involved.

Hydraulic fluids

Hydraulic systems on aircraft incorporate a wide variety of rubber products. Silicone oils, for example, convert most rubbers into a material closely resembling the consistency of a bowling ball. In a like manner, the lubrication system of jet engines presents a number of elastomer problems. Recent tests have shown that all available hose, with the exception of the new Teflon lined hose, is rapidly deteriorated by exposure to new synthetic-base lubricants.

Elastomers research

To obtain elastomers with improved oil resistance and thermal stability, Capt. Brewer stated that the Air Research and Development Command has initiated a long range research program in three areas — fluoroelastomers, modified silicones and inorganic

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for more casting value per dollar

In the words of O. M. Scott & Sons, famous for lawns, "We have been dreaming for 20 years of producing the perfect lawn mower. We have spent the last five years designing the Silent Scott®." The result is a new concept in lawn mowers, underwritten by their five year unconditional warrantee. Look for it at your neighborhood garden or hardware store.

Monarch Aluminum Velvaglaze® permanent mold castings are used for the 6 major parts of the assembly. The main reasons are strength, durability, performance and appearance. Monarch's ability to provide a "one-source", non-competitive analysis of all practical production casting methods contributed to the effectiveness of Scott's design. This same practical approach in your next development program can help you to obtain better end-products at lower factual end-costs.

The 6 major castings are Velvaglazed®—a natural lustrous aluminum, mar-resisting finish.

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Aluminum heat exchanger parts are fluxed and brazed at the same time in this 50KW Ajax® salt bath furnace. Located at the Trane Company, LaCrosse, Wisconsin, the Ajax furnace brazes completed units in a matter of seconds.

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for ALUMINUM ASSEMBLIES

Dip brazing boosts output . . . cuts costs . . . assures fast, sound brazes to close tolerances

Dip brazing in Ajax Electric Salt Bath Furnaces puts the fabrication of aluminum assemblies—even highly complicated ones—on a low cost mass production basis.

Assemblies are preheated to 1000°F. then immersed in the molten salt where all joints are brazed quickly and simultaneously. Distortion is minimized because assemblies are heated uniformly by conduction. Thus, polished surfaces, often difficult to heat by radiation, offer no problem. Moreover, extremely close temperature control, inherent with the salt bath method, eliminates the possibility of overheating.

Clean, fast, high quality brazes to uniformly close tolerances are assured.

AJAX® HULTGREN electric SALT BATH furnaces

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For more information, turn to Reader Service Card, Circle No. 362

polymers. In the field of fluoroelastomers, a fluorinated polyester rubber has been developed that is suitable as a fuel resistant rubber for applications in the temperature range of -65 to 300 F.

Silicone rubber is being modified by adding fluoroalkyl groups in the side chains of the silicone molecular structure. This addition should improve its poor fuel and oil resistance yet make it useable at both high and low temperature extremes. In the inorganic polymer area, several systems are under investigation; they are organo-metallic and organo-metaloidal systems.

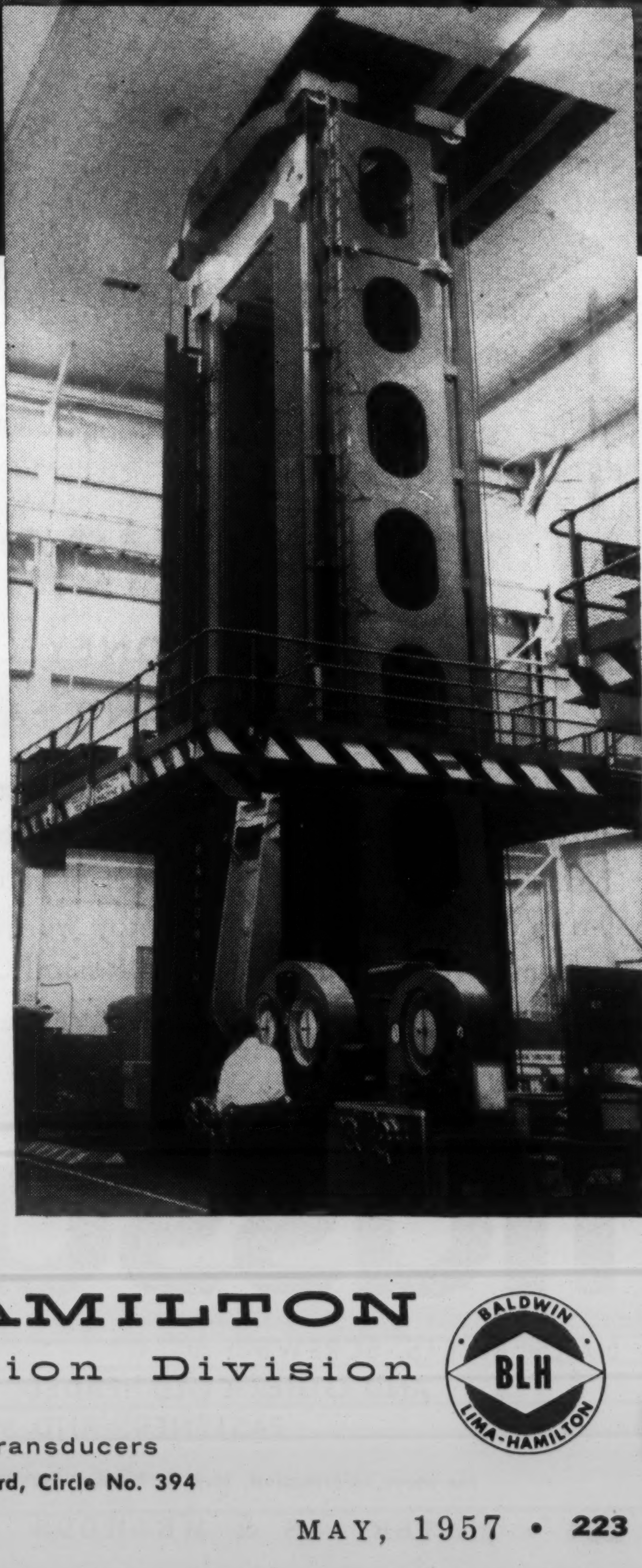
Weapon systems

Another paper given during the conference was concerned with the selection and use of materials for high altitude, high speed missiles, such as the intercontinental ballistics missile. Before these missiles can get off the ground and penetrate outer space, many material problems must be overcome. Possible solutions to some of these problems were discussed by H. C. Sullivan, of Wright Air Development Center.

Mr. Sullivan finds that one of the most serious problems in the

Slag pot—This huge slag pot has a capacity of 480 cu ft and weighs 47,000 lb. Claimed to be one of the largest pots ever made, it is one solid casting — including the flat bottom and three trunnions on either side. It was made by Blaw-Knox Co.

Official Navy photograph



A BALDWIN TESTING MACHINE WAS USED TO FRACTURE THE ANCHOR CABLE OF A CARRIER

For the best in testing, see Baldwin first

Philadelphia Navy Yard's 5-million-lb. Baldwin BTE Universal Testing Machine was used to actually fracture a link similar to those in the anchor cable of the U.S.S. *Forrestal*, newest giant carrier. The Navy has long recognized the importance of testing in its continuing research and development program. In this, Baldwin plays an important role.

For precision performance in production and quality control testing in the shop, or for research testing in the laboratory, Baldwin offers a complete line of testing equipment. The BTE universal testing line, for example, includes many models, standard, semistandard, and specially engineered. Capacities run as low as 10,000 lb. maximum capacity, as high as 5 million lb.

Whatever your testing problem, compression, tension, creep, fatigue, impact or torsion, bring it to Baldwin. Or write today and ask to have a Baldwin representative call on you.

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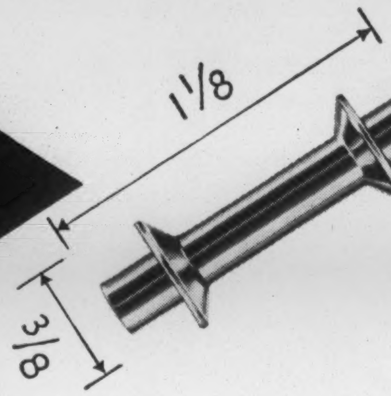
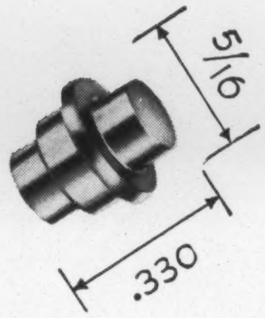
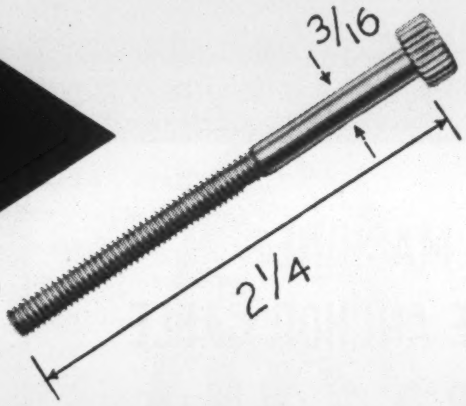


SAVINGS
$12.35
PER THOUSAND
over machine method cost



SAVINGS
$6.80
PER THOUSAND
over machine method cost



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development of materials for high altitude, high speed missiles is the lack of thermophysical data on ferrous, nonferrous and nonmetallic materials. Little can be accomplished in thermodynamic calculations, heat transfer theory, or even predicted physical properties of materials unless their specific heat, thermal conductivity, density and thermal expansion properties are known at the temperatures in which they are to operate. For instance, the high specific heat properties of magnesium make it a choice over and above titanium and aluminum as an aircraft material. The same is true for copper because its thermal properties are much better than its mechanical properties.

Emissivity of material

Another important thermophysical property to consider in missile design is "emissivity of material," which was no more than a physics laboratory specialty a few years ago. Emissivity of material is the ability of a hot surface to radiate energy. At high altitudes, because of the lack of air molecules, this ability of a material to radiate energy becomes a primary method of heat transfer; surfaces facing the sun become extremely hot and surfaces shaded from the sun become extremely cold. The transfer of energy between these two widely separated energy surfaces becomes an important consideration in surface treatment, surface condition and composition of material.

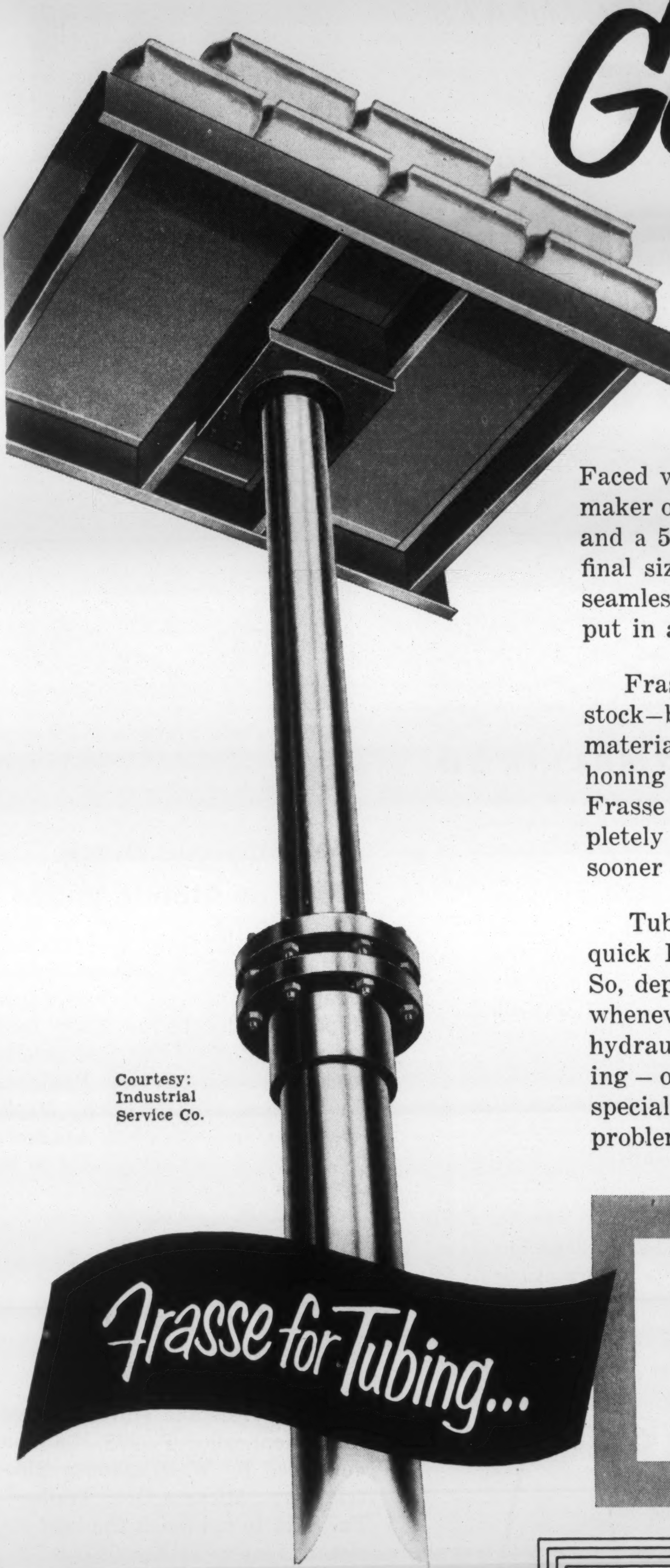
In addition to the papers summarized above, other papers given at the conference were concerned with problems in aircraft materials utilization; aircraft lubricants and hydraulic fluids; and materials approach to advanced weapon systems.

See page 126 for article on airframe materials and aircraft power plant materials adapted from two papers presented at the IAS meeting.

(more What's New on p 226)

Going up...

with a lift from FRASSE stock tubing!



Courtesy:
Industrial
Service Co.

Faced with an almost impossible delivery deadline, the maker of this hydraulic elevator needed a 6″ OD ram and a 5″ OD ram to telescope. Then too, he knew that final sizing would consume valuable time. With Shelby seamless tubing specified – and speed essential . . . he put in a hurried call to Frasse.

Frasse not only made delivery *immediately* from stock–but was able to *select*, from commercial tolerance material, two tubes so close to final size that only minor honing and turning were necessary. This lift from Frasse stock tubing enabled the elevator to be completely installed, approved . . . *and in operation*, days sooner than had been anticipated.

Tubing stocks at Frasse are in good supply – and quick Frasse delivery helps you get jobs done faster. So, depend on a dependable tubing source – *call Frasse* whenever you need mechanical tubing, stainless tubing, hydraulic and pressure tubing, centrifugally spun tubing – or even a bit of assistance from Frasse tubing specialists. They'll be happy to work with you on any problem involving a tubular product.

Seamless and Welded Mechanical Tubing
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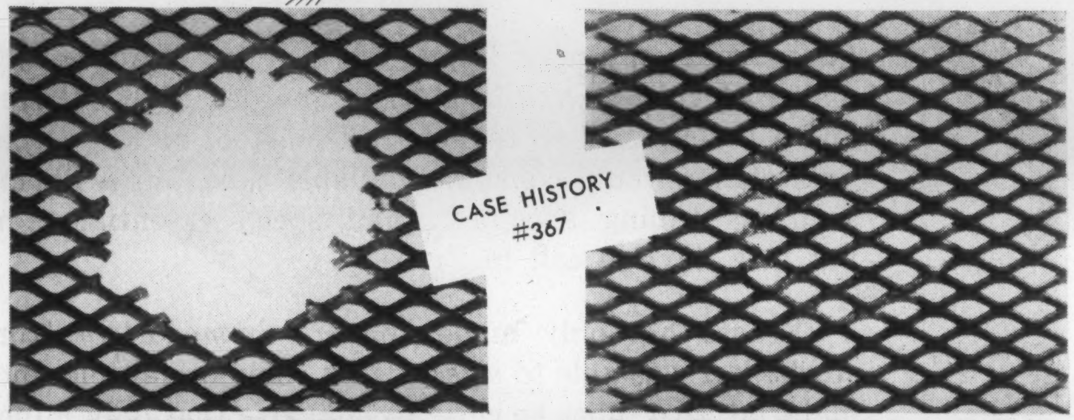
CHROMALLOY PROCESS COMBATS:

HEAT

CORROSION

WEAR



UNTREATED **CHROMALLIZED**

Low carbon steel, tested in gas flame to 1800°F for 24 hours. Expanded metal radiants used in gas range broilers. A leading appliance manufacturer has replaced stainless steel radiants with CHROMALLIZED mild steel at a saving of 26%.

Chromallizing *diffuses chromium into the surface of ordinary iron and steel parts to provide the corrosion and heat resistance of stainless steel, and the wear resistance of chromium carbide. The chromium diffuses uniformly into all recesses, threads and even into blind holes. The case formed is integral with the base steel so that it can't peel, chip or flake.*

Since **Chromallized** *ordinary steels may be substituted for expensive or hard to work materials, substantial savings may be realized in the cost of materials, machining or forming.*

Chromalloy Corporation *is in full production, serving customers in many industries by custom CHROMALLIZING their finished parts or sub-assemblies. Facilities are available for processing your sample parts and for development work.*

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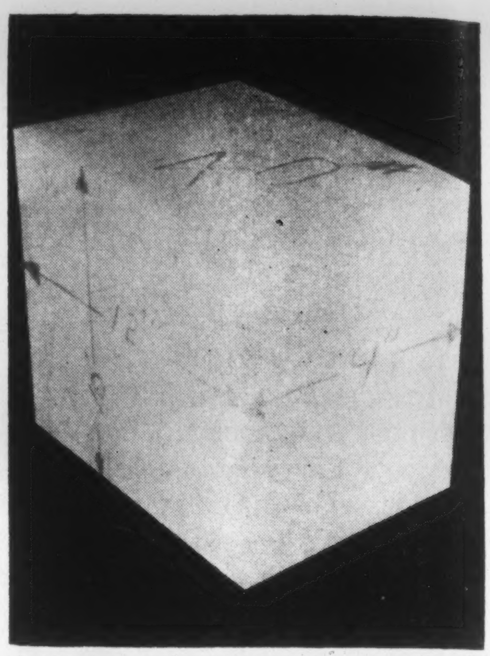
What's new IN MATERIALS



Polyethylene block *makes a lighter weight shield for atomic reactors than lead.*

Polyethylene Block Used as Atomic Shield

A 40-lb block of polyethylene, believed to be the largest molded shape ever produced from linear type polyethylene, is being used as a replacement for lead shields used in atomic reactors. Produced by American Agile Corp., Maple Heights, Ohio, the block measures 10 x 12 x 9 in. and is said to be entirely free from voids.

Coated Insulation Is Heat Resistant

A heat resistant, silicone coated insulation, called T-9278, has been developed by Westinghouse Electric Corp., Micarta Div., Trafford, Pa. Said to approach the heat resistant requirements of Class "H" silicone materials, the insulation is made of flexible, straight weave, continuous filament glass fabric coated with a modified silicone resin.

The material is said to show good resistance to both toluene and alcohol after aging for 48 hr at

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Only your *imagination* limits the ways you can use Ampco Alloys

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Should your part be sand-cast, centrifugally cast, shell-molded, precision-cast, forged, fabricated or extruded?

Let an Ampco field engineer help you to select the best, most economical form of production. It's all part of Ampco's one-source service to industry

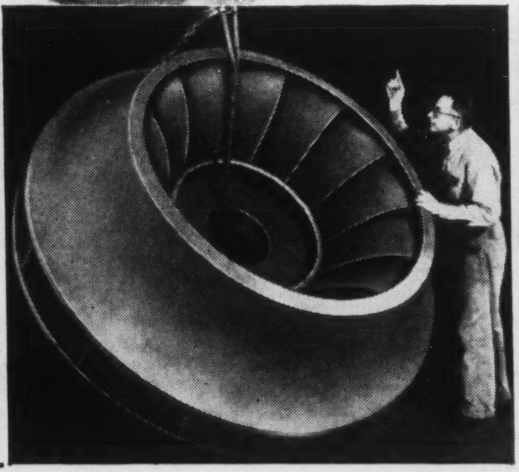
And he can help you select the best alloy, too. For among more than 100 Ampco copper-base alloys is the one you need to do the job — to resist wear, corrosion, impact, fatigue — to provide excellent bearing qualities — to retain physical characteristics at temperatures from 600°F down to −400°F.

So call in your Ampco field engineer and get his unbiased recommendations.

D-53

Write for Bulletin 33.

5,400-lb. centrifugal casting for flywheel of a marine engine. Ampco makes centrifugal castings from a few pounds to five tons.



12,000-lb. sand-cast water wheel. Ampco's sand foundry makes any-size casting to 14,000 pounds — sand, shell moldings, cast-to-size, cement.

Ampco's one-source service includes production-run machining of Ampco copper-base alloys to the exacting quality standards of the aircraft industry.

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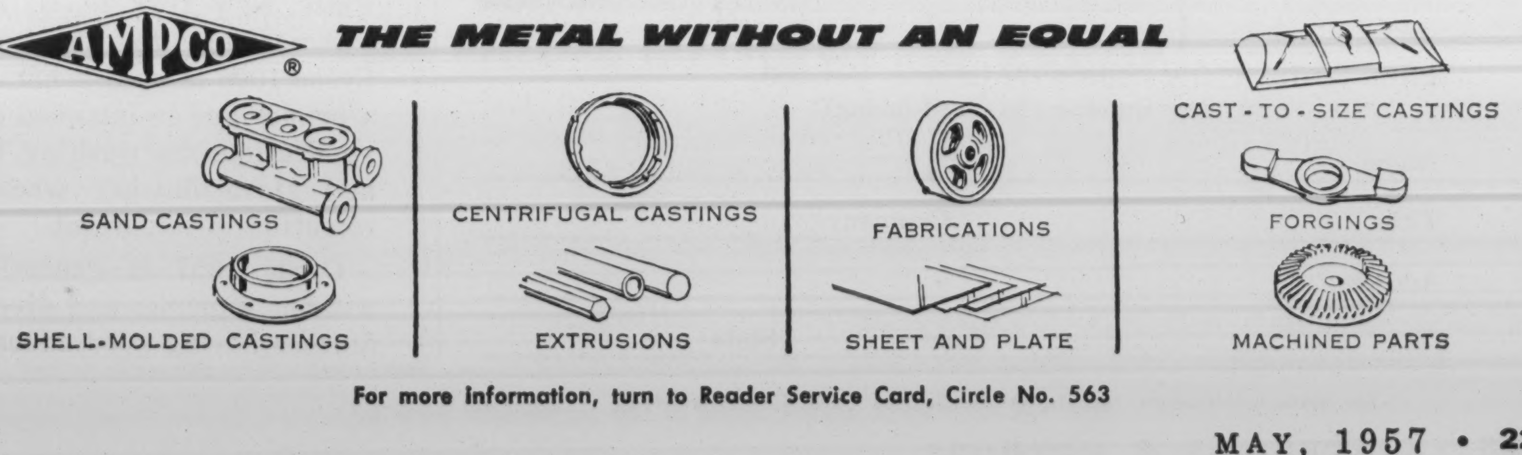
THE METAL WITHOUT AN EQUAL



For more information, turn to Reader Service Card, Circle No. 563

NEW IMPROVED HARD FACING

Tough, hard ceramic coatings provide superior bearing surfaces

Sprayed alumina forms "sapphire-hard" surfaces highly resistant to wear, abrasion and corrosion. Ideal for bearing surfaces, seals.

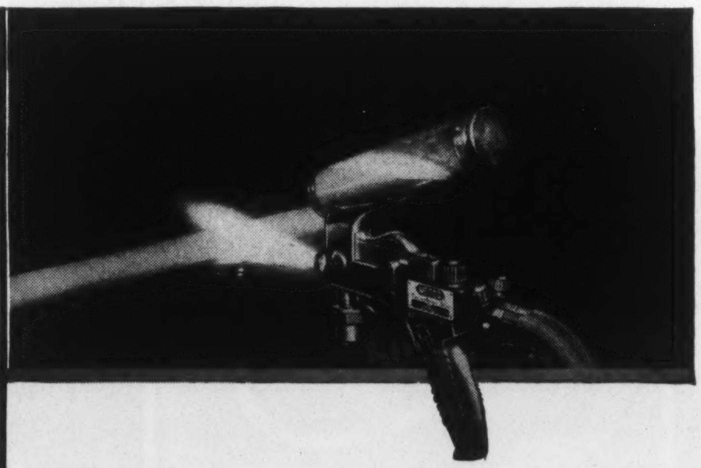
Development of the new METCO THERMOSPRAY GUN for spraying high-melting-point ceramic materials at low cost opens up a variety of new practical applications. One that has produced a great deal of interest is the use of sprayed alumina coatings for bearing surfaces and mechanical seals. This THERMOSPRAY 101 Ceramic Powder produces surfaces with a hardness of 9.0 on the Moh scale, (only the diamond rates 10.0) with excellent resistance to wear, abrasion and corrosion. When used in combination with special phenolic or furane plastic sealers it provides superior protection against many acids.

Another THERMOSPRAY Powder – 201 – is zirconia which is somewhat softer than No. 101 but provides superior heat-insulating properties. Melting point of this material is 4600° F. and particle hardness 8.0 on the Moh scale.

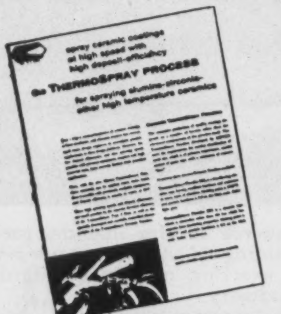
Hard-facing alloys of the self-fluxing, nickel-boron-silicon type in powder form can also be applied with the METCO Type P THERMOSPRAY GUN. These coatings may be fused, semi-fused, or left unfused depending on the hardness desired, from RC 30 to RC 65, depending on the alloy and the process used.

The new THERMOSPRAY GUN operates without compressed air, only oxygen and acetylene being required. The free-flowing THERMOSPRAY powders are fed to the flame nozzle from a hopper atop the gun, melted and propelled to the surface to be coated. These materials are sprayed many times faster (up to 15 sq. ft. per hour–.010" thick) than has been possible with equipment previously available. Deposit efficiencies are in excess of 95%. These factors result in extremely low coating costs.

Preliminary engineering data contained in Bulletin 127 covers ceramic coatings while Bulletin 126 covers the hard-facing alloys. Either or both may be obtained by filling out the coupon below or writing on your company's letterhead. No obligation, of course.



Pump rod sprayed with alumina provides superior protection against abrasion and corrosion.



free bulletins
(See last paragraph above)

The following trade names are the property of Metallizing Engineering Co., Inc. METCO, THERMOSPRAY. *Reg. U.S. Pat. Off.*

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Please send me ☐ free Bulletin 127 (ceramic coatings)
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Name
Title Company
Address
City Zone State

For more information, turn to Reader Service Card, Circle No. 485

What's new IN MATERIALS

room temperature and is also said to have good hot oil resistance. Short time dielectric strength is 1250 v/mil after aging for 1000 hr at 392 F. According to the company, the new insulating material has a ten-year life at 350 F based on extrapolated data.

Reinforced Plastics Strengthened by Metals

Glass-reinforced plastics panels containing embedded aluminum or steel diamond mesh have been introduced by Resolite Corp., Zelienople, Pa. Called Security Junior, the new panels have high impact resistance due to the metal mesh reinforcement. The aluminum-plastics panels consist of 0.081-gage expanded aluminum embedded in flat plastics sheets. The steel-plastics panels contain 16 to 18-gage expanded steel.

The sheets are available in standard and fire retardant types, either clear or colored. They may be purchased in lengths of 8 and 10 ft and in widths of 1, 2, 3 and 4 ft.

Two Metal Finishes Are Impact Resistant

Two new fast curing metal finishes are said to combine exceptional impact resistance with outstanding chemical resistance and maximum hardness. The finishes, Cyzac 1006 and Cyzac 1007, were announced recently by American Cyanamid Co., Plastics & Resins Div., 30 Rockefeller Plaza, New York 20, N. Y.

According to the company, Cyzac 1006 is used generally with a primer and is intended for such applications as washing machine and stove finishes where color retention is important.

Cyzac 1007 is generally used without a primer and gives baked finishes having good adhesion and

TAYLOR
Laminated Plastics
Vulcanized Fibre

Shop Talk

TAYLOR FIBRE CO.
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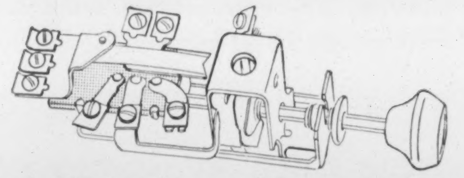
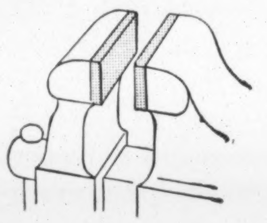
PHENOLIC—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • COPPER-CLAD LAMINATES • VULCANIZED FIBRE

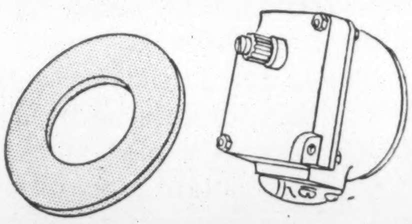
Tips for designers



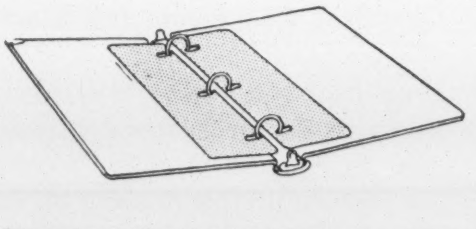
Back plate on an automobile headlight switch, punched and machined from Taylor Grade XP paper base laminate, has low moisture absorption and good dielectric strength.



Vise jaw caps, made of Taylor Grade C phenolic laminate, are easily cut and machined to shape. Marring of precision or delicate parts is eliminated.



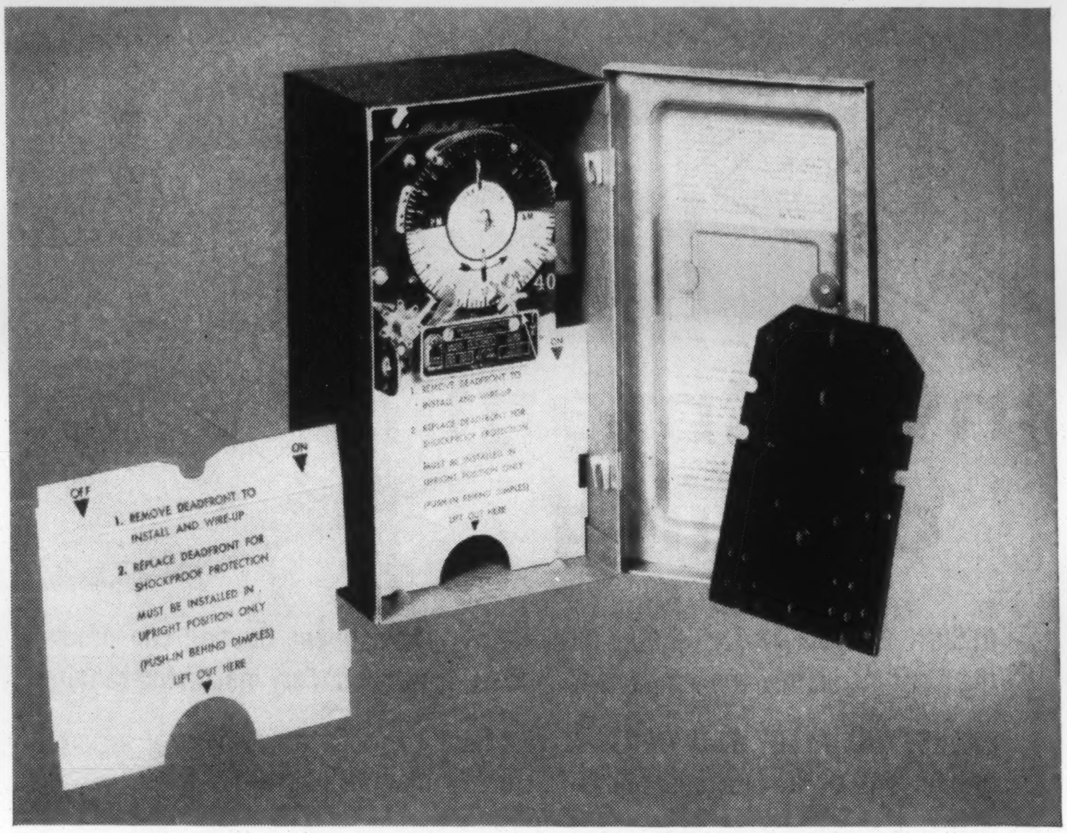
Self-balancing servo motor has stator case insulator which is cold-punched from 1/64" thick Taylor Paper Base Phenolic Laminate sheet.



Flippers for loose-leaf binders are made of economical Taylor Vulcanized Fibre . . . affording added rigidity and good protection for the paper pages.

TAYLOR SUPERIOR COPPER-CLAD LAMINATES

Taylor GEC (glass epoxy) Copper-Clad and Taylor XXXP-242 cold punching (paper-phenolic) Copper-Clad. Taylor uses high purity rolled copper on base materials with outstanding electrical properties.



OFF
ON
1. REMOVE DEADFRONT TO INSTALL AND WIRE-UP
2. REPLACE DEADFRONT FOR SHOCKPROOF PROTECTION
MUST BE INSTALLED IN UPRIGHT POSITION ONLY
(PUSH-IN BEHIND DIMPLES)
LIFT OUT HERE
40

Time switch, made by the Tork Clock Co., uses two Taylor products . . . the deadfront is made of vulcanized fibre for its insulating properties, shock protection and printability . . . the mounting panel of the clock is made of Taylor laminate XP-1-231, chosen for high strength and good punchability.

Have an Insulation Problem?

Taylor will provide the answer . . .

Select from Taylor's complete line of materials—laminates and vulcanized fibre—to get the right combination of electrical, physical and machining properties for your product. And, if you have a unique problem, Taylor will develop a special material to meet your requirements.

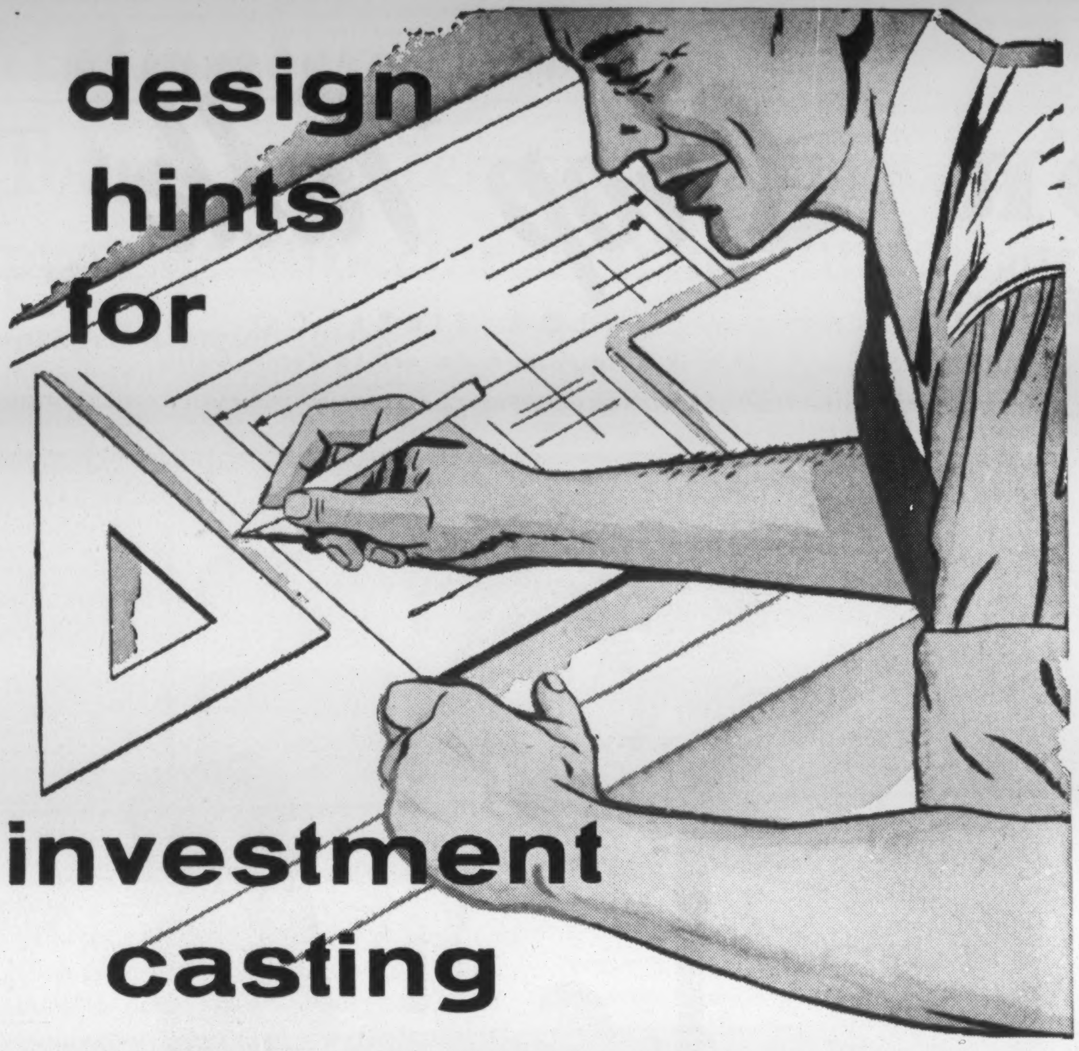
For example, rigid requirements for insulation materials in the Tork Clock Company's Time Switch were met by two Taylor materials—a laminate and vulcanized fibre. The mounting panel is made of Taylor laminate XP-1-231, especially formulated for the high strength and good punchability requirements of this application. In addition, Taylor vulcanized fibre serves as the deadfront—a shockproof cover removed only for installation and service. Fibre was chosen for its insulating properties, shock protection, and printability.

Taylor materials are developed to meet the need for dependable, moisture-resistant insulation. They have high dielectric and mechanical strength, and maintain original characteristics over long periods of time, under severe operating conditions. When you choose—and use—Taylor products, you'll have performance with stability.

Taylor application engineers can help you obtain the Taylor material that matches the exact requirements of your product. Contact your nearest Taylor sales office.

For more information, turn to Reader Service Card, Circle No. 518

design hints for investment casting

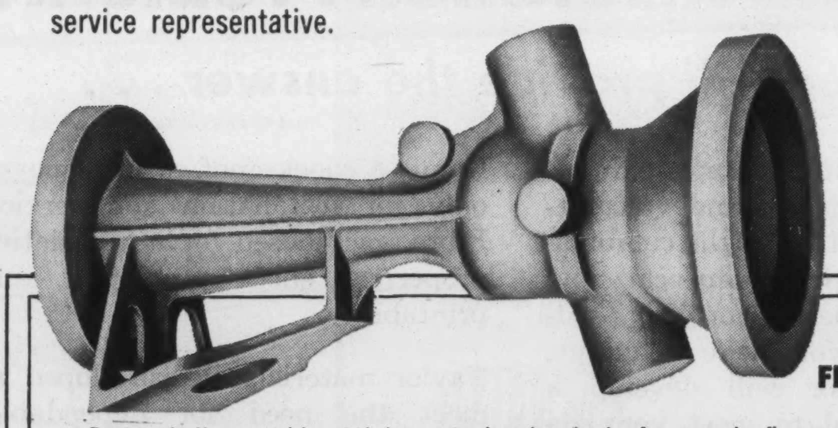


DESIGN PARTS FOR THE SHAPE YOU WANT—Investment Casting can produce the most intricately shaped parts with little or no secondary machining required.

CHOOSE THE ALLOY YOU WANT—Investment Castings are produced in any of the ferrous or non-ferrous alloys, including magnesium.

USE THE PROCESS WISELY—Give full consideration to weight, dimensions, tolerances and surface finishes when designing for Investment Casting. Take full advantage of the economies inherent in the process.

CONSULT ARWOOD ENGINEERS—Arwood casting engineers will gladly consult with you on your design and production problems, helping you translate them into finished products. Write for the name of your nearest ARWOOD sales and service representative.



DESIGN FLEXIBILITY

Parts similar to this stainless steel valve body for an air flow controller often require several changes before design is finalized. Due to the relatively low cost of dies and die changes, the investment casting process has proven an inexpensive and flexible method.

ARWOOD

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impact resistance. The resin is recommended as a finish for refrigerators, electrical appliances, metal cabinets, furniture, hospital equipment and toys.

Both resins, modified with rezyl alkyds, are compatible with most commonly used pigments.

New Data Available on Linear Polyethylene

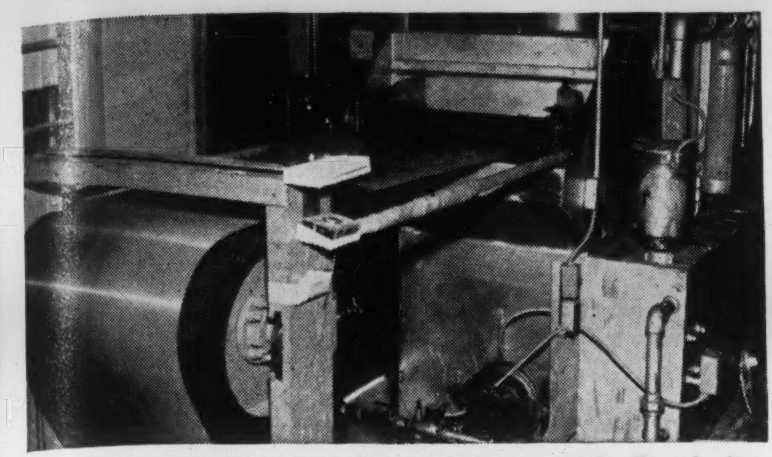
The introduction of the organometallic catalyst system in 1954 resulted in the development of low pressure or linear polyethylene. Compared with branched or high pressure polyethylene, linear polyethylene is a more crystalline polymer, having higher heat distortion temperatures, lower permeability, increased tensile strength, and improved chemical resistance.

Melt spun fibers

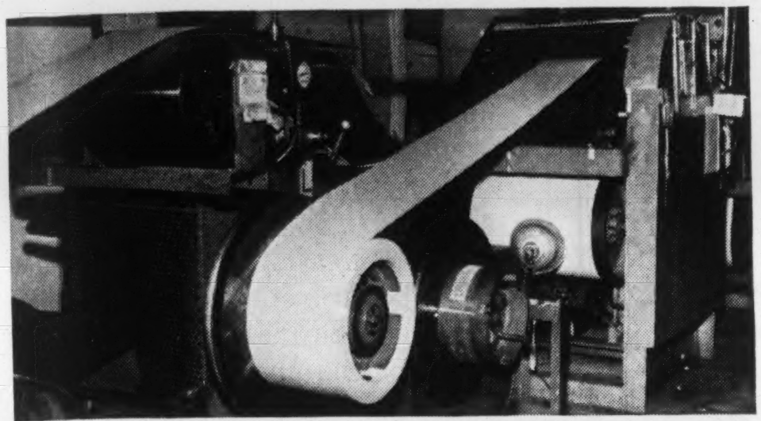
Among the initial areas of investigation for this high polymer was its use as a melt spun fiber. In order to obtain more information on the properties and fabrication characteristics of this material, A. T. Widiger, G. H. Youse and T. C. Broadwell of the Dow Chemical Co., conducted a series of comparative tests on Saran, branched and linear polyethylene fibers. They presented the data at the thirteenth annual technical conference of the Society of Plastics Engineers, held earlier this year in St. Louis. Results of their

PHYSICAL PROPERTIES OF POLYETHYLENES

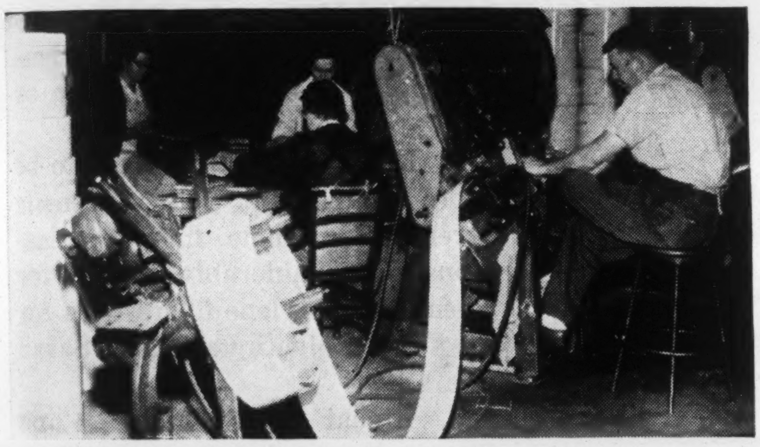
	Polyethylenes	
	Linear	High Pressure
Tensile Strength, psi	3500	1800
Elongation, %	225	475
Specific Gravity	0.950	0.917
Crystallinity, %	85	47
Vicat Softening Point, F	255	190
Mold Shrinkage, in./in.	0.035	0.022



Strip emerges after its treatment with Bonderite, corrosion resistant paint bond.



Painted metal is slit to desired width and re-coiled as it emerges from finishing machine.



Re-coiled, finished metal is cut, formed, and inspected here. No loss of paint adhesion.

Painted stock is fed into punch press for blanking into various shapes and sizes.

Photos courtesy
Hastings Aluminum Products, Inc., Hastings, Michigan

Bonderized... Painted... Formed...

NO LOSS OF PAINT ADHESION!

Here's a production wrinkle that more and more manufacturers are using: Finish metal in the strip, then fabricate the product.

The technique applies equally well on steel and aluminum. First, run the strip through the Bonderite machine to produce the integral conversion coating that supplies a secure anchor for the paint. Next, run the Bonderized strip through roll-coat painting and the bake oven. The painted coils of metal are ready for fabrication, and the finish doesn't crack, chip or craze as it is formed, drilled, and punched.

Fabrication after painting, made possible by Bonderizing, saves money by reducing labor, handling and manufacturing area requirements, and allows higher production rates.

Write or call for more information on how you can finish before fabrication in your plant.

Bonderite, Bonderizing, Bonderized—Reg. U.S. Pat. Off.

Since 1914— leader in the field

PARKER RUST PROOF COMPANY
2173 E. MILWAUKEE, DETROIT 11, MICHIGAN

BONDERITE corrosion resistant paint base

BONDERITE and BONDERLUBE aids in cold forming of metals

PARCO COMPOUND rust resistant

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TROPICAL heavy duty maintenance paints since 1883

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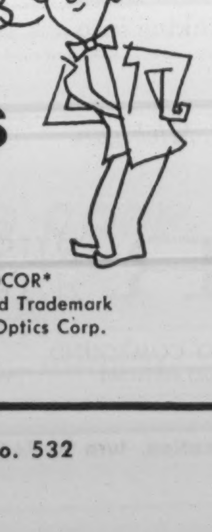
HARDER SURFACE! HIGH RESISTANCE TO SCRATCHING... TO CHEMICAL AND ACID ATTACK... TO IMPACT AND HEAT
ACID

RIGID CR-39 OPTICALLY CLEAR PLASTIC SHEETS

It's superior to any other plastic! If you need an optically clear, rigid, thermosetting plastic sheet that looks like plate glass yet is half the weight, specify CR-39—has greater resistance to impact, crazing, chemicals, acids, wear, abrasion and weathering. Here are some of the hundreds of uses for this amazing plastic:

- Protective lens for welding helmets
- Instrument dials, panels and windows
- Plastic mirrors
- Plotting surfaces
- Photographic filters
- Marine windows
- Safety guards and goggles
- X-ray equipment and accessories
- Projection slides

We can supply in sheet form, thicknesses from .030 to .500, or precision-fabricate and cut to your exact needs. Write or phone today for complete details, specifications and samples of CR-39. WE ALSO MANUFACTURE **EVR-KLEER** RIGID CAST ACRYLIC PLASTIC SHEETS AND OTHER SPECIAL FORMULATIONS.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findings are summarized below.

1. Tensile strength of linear polyethylene fibers varies considerably due to fluctuations in existing polymers at this relatively early stage of fiber development. Recently produced linear polyethylene fibers show considerably higher tensile strengths than any branched polyethylene available. Tensile strengths over 100,000 psi are possible with fibers smaller than 0.010 in. dia.

2. Elongation for Saran and branched polyethylene fibers seems to be about equal to that of linear polyethylene fibers.

3. Tensile modulus data shows that linear polyethylene fibers are stiffer than branched polyethylene or Saran fibers. In fabric constructions, linear polyethylene fibers are boardier than Saran or branched polyethylene fibers.

4. Knot strength, thought to be more important than tensile strength in some fiber applications, is considerably higher for linear polyethylene fibers than for branched polyethylene and Saran fibers.

5. Linear polyethylene and Saran fibers shrink about 5 to 10% in boiling water; branched polyethylene fibers have high shrinkage which prevents their use as a normal fabric material.

6. Of the three fibers tested, only Saran has good bend recovery. This characteristic may be a major disadvantage of linear polyethylene fabrics.

7. Flex life of linear polyethylene samples exposed to ultraviolet light shows an extremely sharp drop when compared with Saran fibers which were only slightly affected. A more stable polymer should bring about improvements in this characteristic.

Actual physical property data are shown in the accompanying table (see p 234).

Mold shrinkage

Another paper given at the conference contained information on molding linear polyethylene in

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conventional molding equipment. The authors, R. W. Miler and F. T. Hughes, also of Dow Chemical, noted certain similarities between the properties and characteristics of linear polyethylene and high pressure polyethylene. For instance, specific heat and thermal conductivity of linear polyethylene is similar to high pressure polyethylene. However, there is a wide range of difference in crystallinity of the two polymers, namely, 50% for high pressure polyethylene and 85% for linear polyethylene. This difference in crystallinity has a bearing upon physical properties of the two materials as noted in the accompanying table.

Since linear polyethylene is more crystalline than branched polyethylene it has the greater shrinkage of the two. At low mold temperatures, linear polyethylene shrinks 2.5% compared with 1.5% for branched polyethylene; at high mold temperatures linear polyethylene shrinks 4.8% compared with 3.0% for branched polyethylene.

Since it is known that linear polyethylene shrinks more than branched polyethylene, the authors suggest a number of ways to overcome this mold shrinkage. A summary of their findings is listed below:

1. The major portion of mold shrinkage for linear polyethylene occurs within the first 24 hr after fabrication; after this period linear polyethylene appears to

PROPERTIES OF FIBERS

Property	Polyethylenes	
	Branched	Linear
Density	0.92	0.95
Tensile Strength, psi	40,000	75,000
Elongation, %	23	19
Modulus, psi	300	1750
Knot Strength, psi	14,000	50,000
Immediate Shrink in Boiling Water, %	50	7
Bend Recovery, %	56	56
Fabric Flex Life, Cycles	—	55,000

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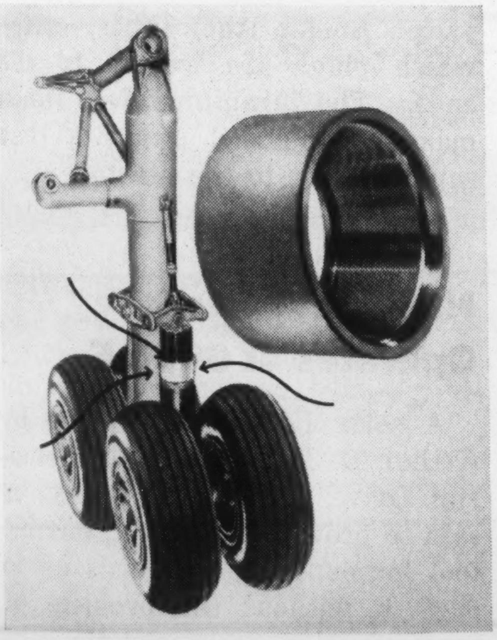

Synthane (arrow) serves as bearing in landing gear shock struts.

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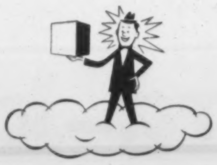

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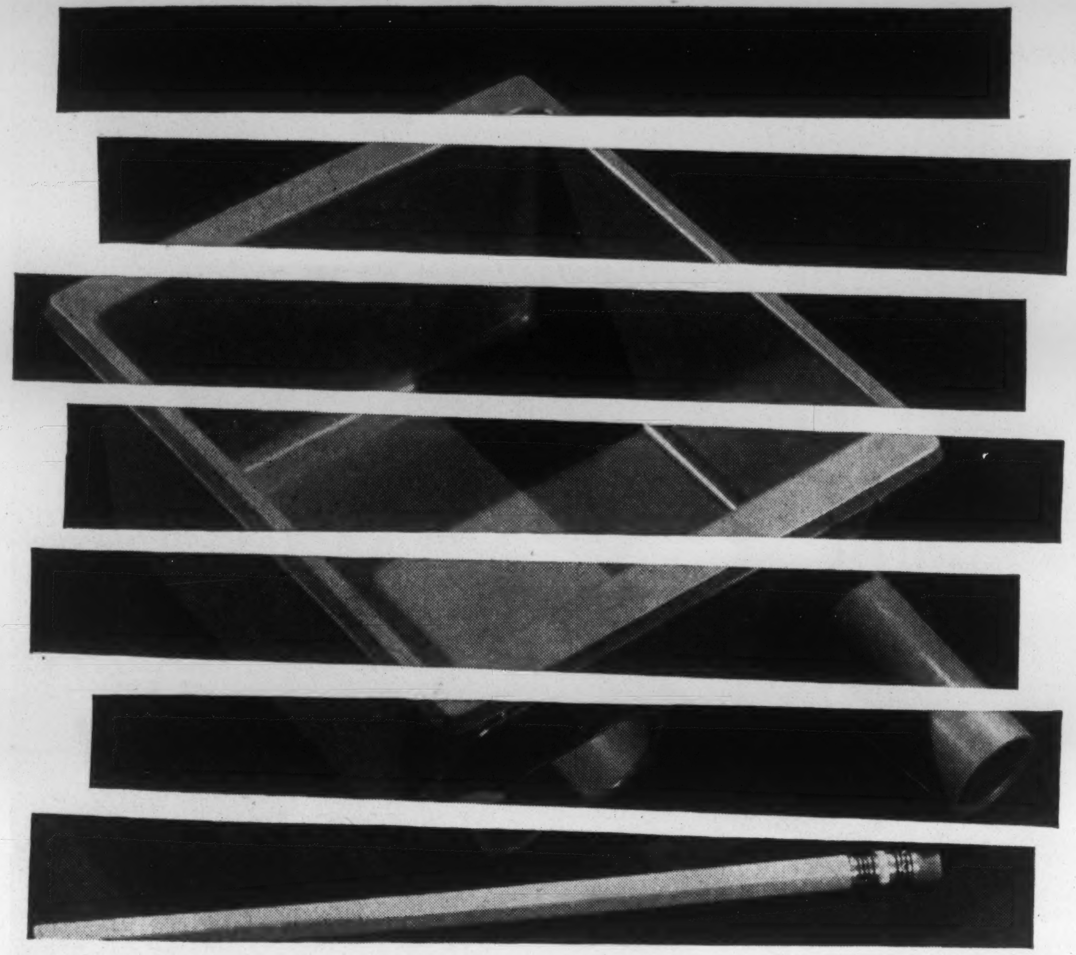

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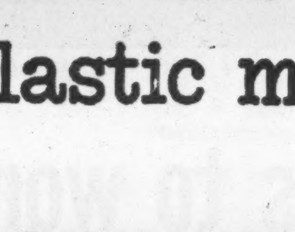

have good dimensional stability.

2. Conditions used in molding linear polyethylene are determined primarily by mold design and physical property requirements of the molded part. For instance, high cylinder temperatures, high pressures and low mold temperatures offer the best combination of properties. However, low mold temperatures produce parts with poor surface finish. In order to overcome poor surface finish the authors recommend high molding pressures.

Zirconium Tubing for Nuclear Reactors

Superior Tube Co., Norristown, Pa., is producing zirconium tubing for use in nuclear reactors. The tubing, made from an alloy of zirconium, iron, chromium, tin and nickel, is annealed in a vacuum furnace to prevent the absorption of contaminating gases. At present, the tubing is being used in a pressurized water reactor at the Duquesne Light Co. Uranium is placed inside the tubes, after which plugs are welded to the ends. The uranium-filled tubes make up the fuel elements that supply power to the reactor.

New Solar Furnace Operates at 6000 F

A solar furnace, developed by Arthur D. Little, Inc., 30 Memorial Drive, Cambridge, Mass., is said to provide a compact, flexible tool for exposing materials up to 6000 F without the problem of contamination from sample containers or furnace walls.

Called the ADL Solar Furnace, the unit consists of a 60-in. dia parabolic mirror with the front reflecting surface coated with Stellite. The unit also contains a sample moving mechanism that

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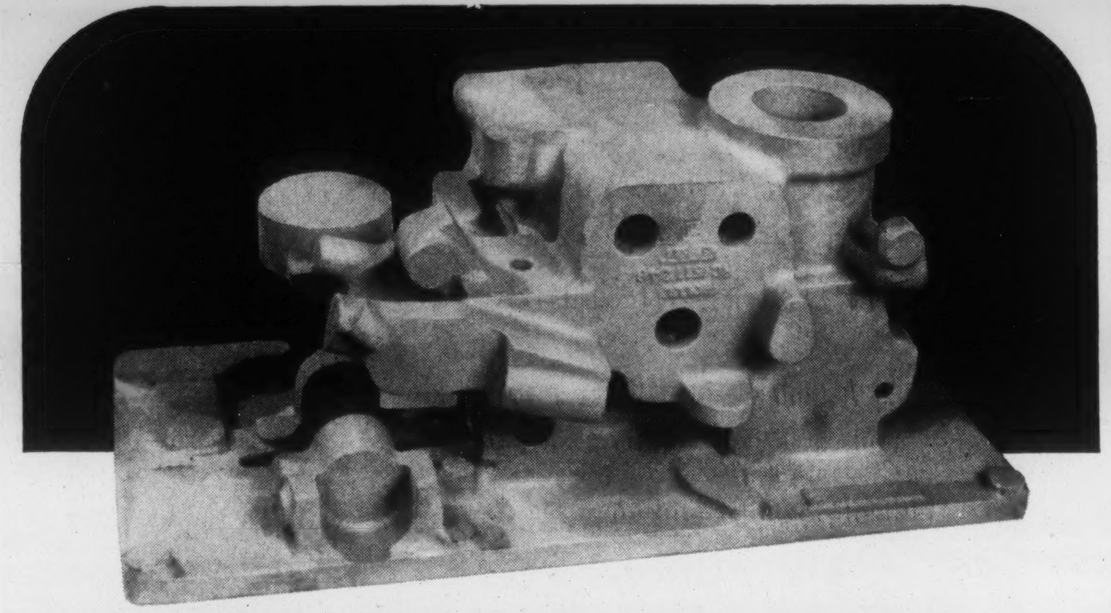

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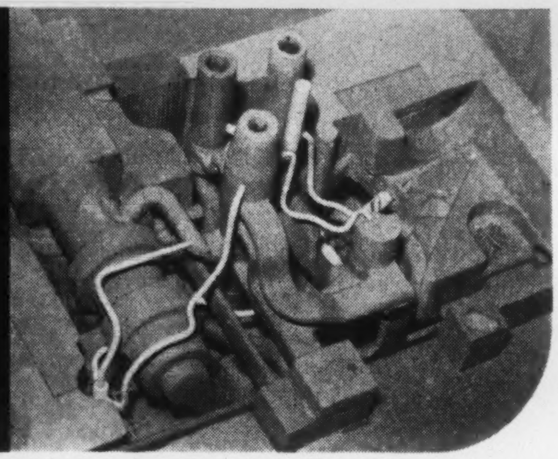

intricate internal cored passages for above casting

This extremely complex aircraft valve body is currently being sand cast by Rolle in two aluminum alloys . . . 355T6 and 356T6. But as part of a continuing program of casting research, Rolle has also poured the piece with equal success in ZRE1 and A-142. While A-142 does not yet have the acceptance of many other alloys, Rolle is extremely interested in its possibilities in high temperature applications.

The valve body is an ideal test piece for such research. Few castings offer a tougher trial of as-cast properties. The many small diameter passages through the piece demand intricate tube coring as well as the more conventional sand cores. The tubes are removed after casting by a process developed in Rolle's Research Laboratory.

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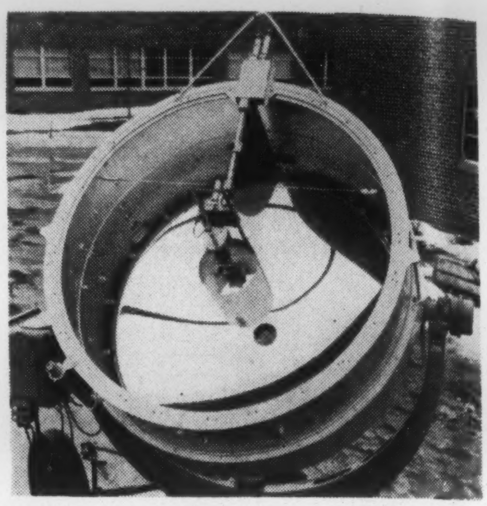

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permits movement of the sample in all directions.

Research advantages claimed for the furnace are: ability to turn heat on and off almost instantaneously or to moderate it rapidly through a system of shutters; no contamination from thermochemical reactions with the walls of a heated container; produces a "clean heat" that is uncontaminated by combustion products from fuels. One disadvantage of solar furnaces is their inability to work when the sun does not shine. Meteorological studies, however, have shown that there are enough clear days, even in northern climates, to economically operate the unit on a year-around basis.

How Hot Working Affects Heat Resistance

The influence of hot working conditions on the high temperature properties of heat resistant alloys and the effect of hot working on response to subsequent heat treatment have been subjects of much investigation. However, very little information is available which explains the fundamental causes for variations in properties at high temperatures.

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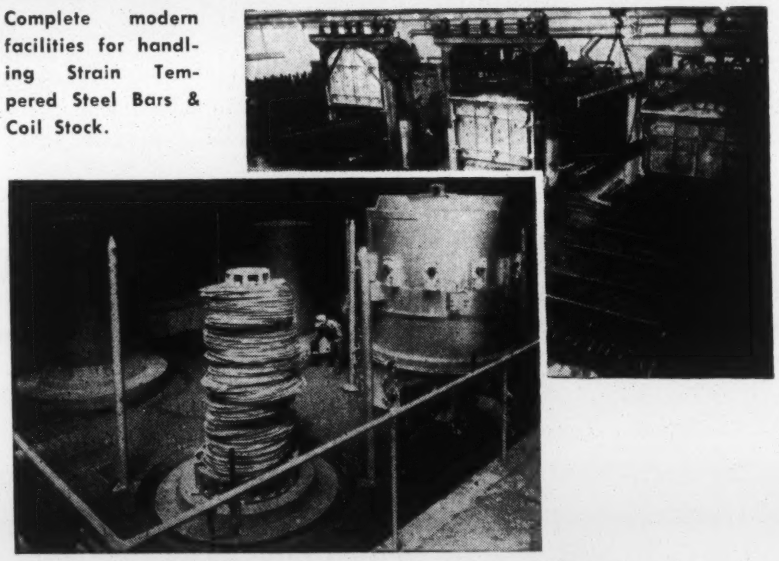

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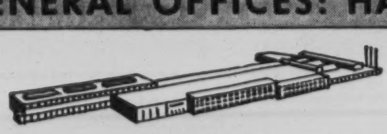

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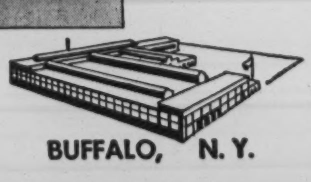

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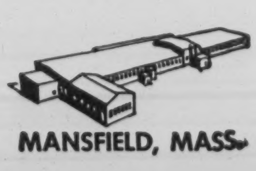

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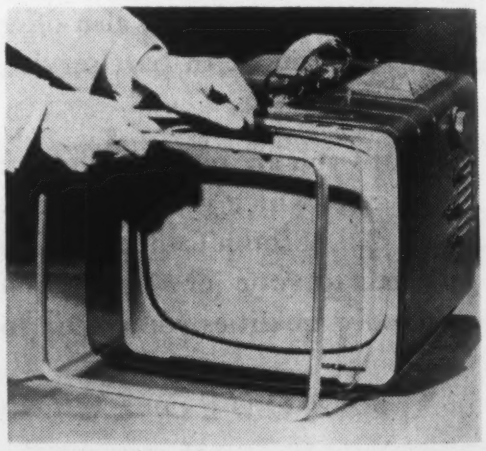
search to uncover specific data along these lines. The research was sponsored by the National Advisory Committee for Aeronautics and conducted by the Engineering Research Institute of the University of Michigan.

Materials and conditions

The composition of the particular alloy studied was nominally 0.15 carbon, 20 chromium, 20 cobalt, 3 molybdenum, 2 tungsten, 1% columbium and the balance iron. Commercially produced bar stock was solution treated at 2200 F to minimize prior history effects and then rolled at temperatures of 2200, 2100, 2000, 1800 and 1600 F. Working was carried out at constant temperature and with incremental decreases in temperature simulating a falling temperature during hot working. In addition, a few special repeated cyclic conditions involving a small reduction at a high temperature followed by a small reduction at a low temperature were used to study the possibility of



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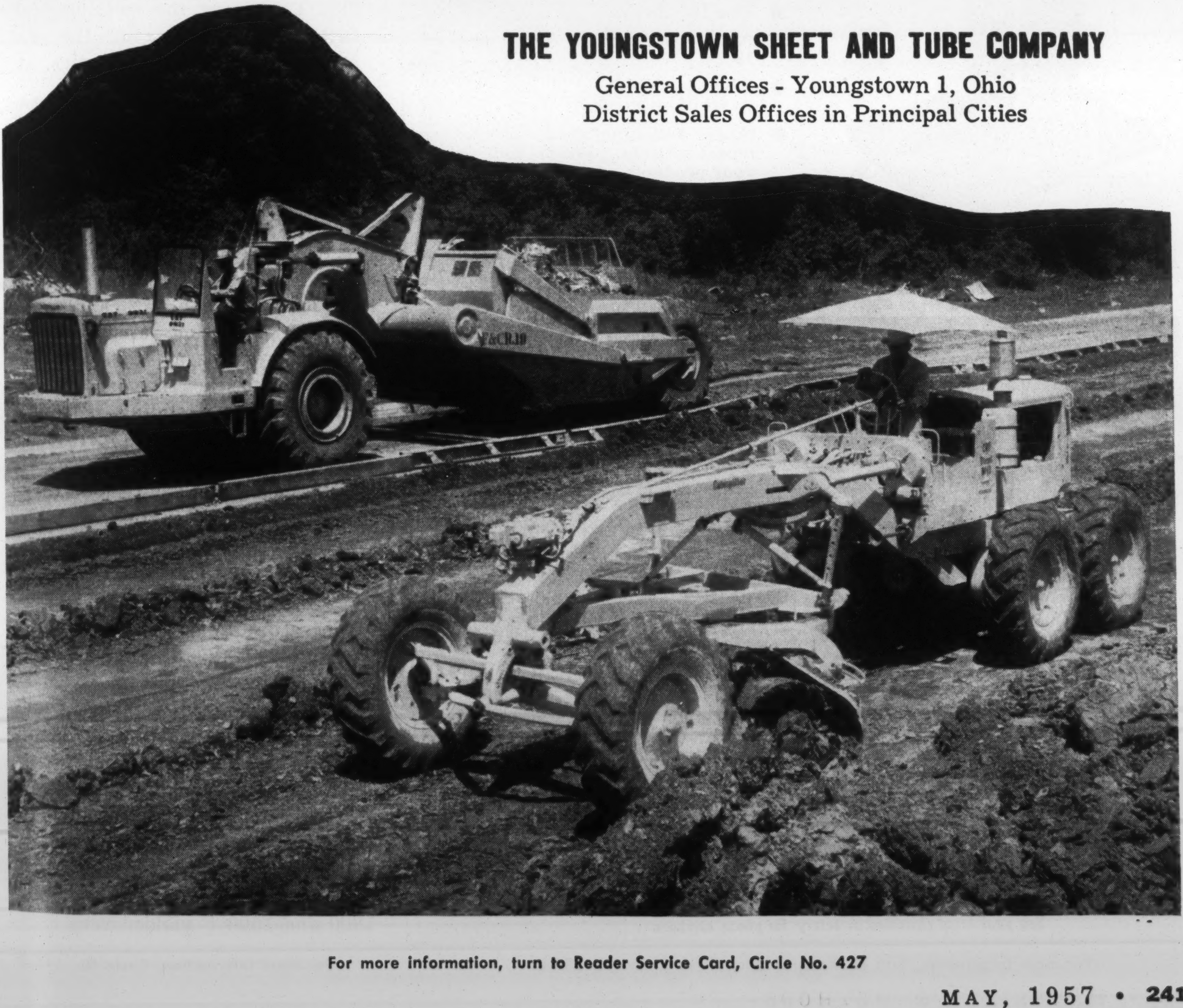

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inducing very low strengths by the extensive precipitation accompanying such procedures. Most of the rolling was done in open passes, with a few check tests made with closed passes. Reductions up to 40% were used, with some carried to as high as 65%. Heat treatments at both 2050 and 2200 F subsequent to working were used to study the influence on response to heat treatment.

Evaluation of the effects of rolling was based on rupture tests at 1200 F and 1500 F, on creep rates during the rupture tests, and on creep rates for stresses of 25,000 psi at 1200 F and 8000 psi at 1500 F. Hardness, microstructures, and lattice-parameter measurements were used to obtain data explaining the metallurgical factors responsible for the observed effects on properties at high temperatures.

Results of tests

1. Strengths increased to maximum values and then remained constant or decreased as the amount of reduction at constant temperature was increased. Optimum reductions were generally no more than 15% and were less for long-time creep resistance. Strengths at 1200 F were sensitive to the temperature of hot working, tending to decrease as temperature increased. Strengths at 1500 F were relatively insensitive to temperature of working. Strengths at both temperatures were dependent on the degree of reduction.

2. Working over a decreasing temperature range induced higher strengths at 1200 F than can be obtained by working at a constant temperature. Strengths at 1500 F were not improved very much in relation to isothermal reductions of the same degree. Low strengths were obtained only when recrystallization continued at all temperatures of working.

3. Repeated working between 1800 and 1500 F yielded very low

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strengths, while upper temperatures of 2000 and 2200 F gave quite high strengths.

Metallurgical explanation

Although metallurgical causes for the observed variations in strength and ductility were not definitely established, the data suggest that:

1. Strain-hardening is a major source of strengthening, although other factors are involved.

2. Recovery effects due to recrystallization appear to limit strengthening and cause a decrease in strength with increasing reduction past the optimum amounts.

3. As a result of the fall-off in strength for more than optimum reduction, subgrain structures are developed as a mechanism. The decrease in the amount of reduction for reduced strength and the accumulative damage effects for low-stress creep suggest that weakening involves a recovery process in the grain-boundary regions, as suggested by the fact that recrystallization started first in such areas.

4. Because rupture strengths at 1200 F did not fall off much with more than the optimum reduction of 15%, the damage component of working has less influence on the resistance to the more uniform crystalline slip processes of creep at relatively low temperatures and high stresses than on the more viscous creep processes at low stresses and/or higher temperatures.

5. An extensive precipitation reaction at 1600 to 2000 F reduces long-time rupture strength at 1200 F. This heretofore unrecognized precipitation reaction also induces extensive precipitation at 1200 F. Apparently it had little effect at 1500 F because of the extensive precipitation for all conditions during testing at that temperature.

6. Apparently some effect of the precipitation reaction is in-

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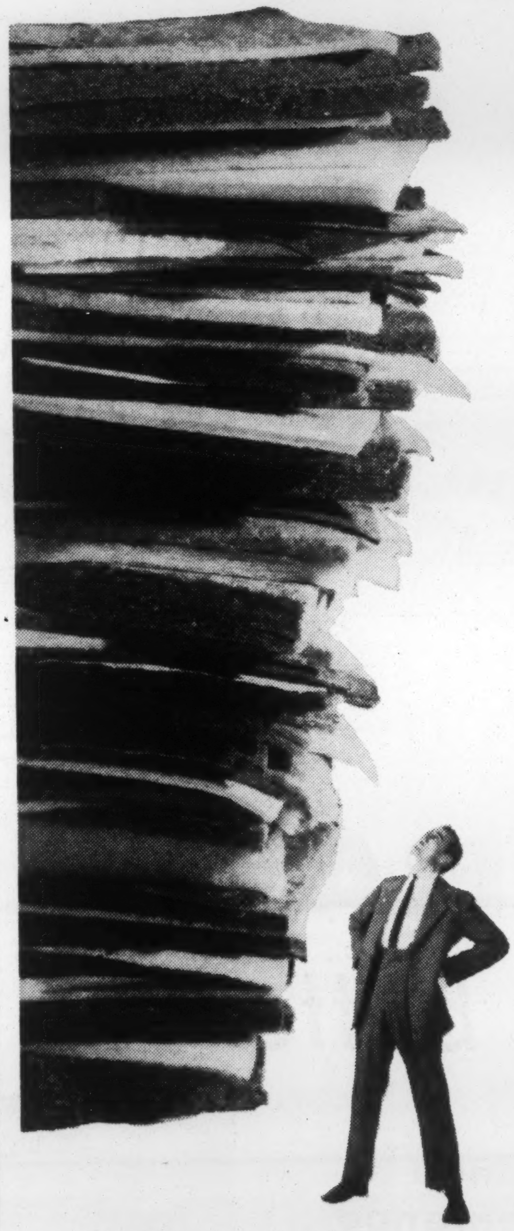

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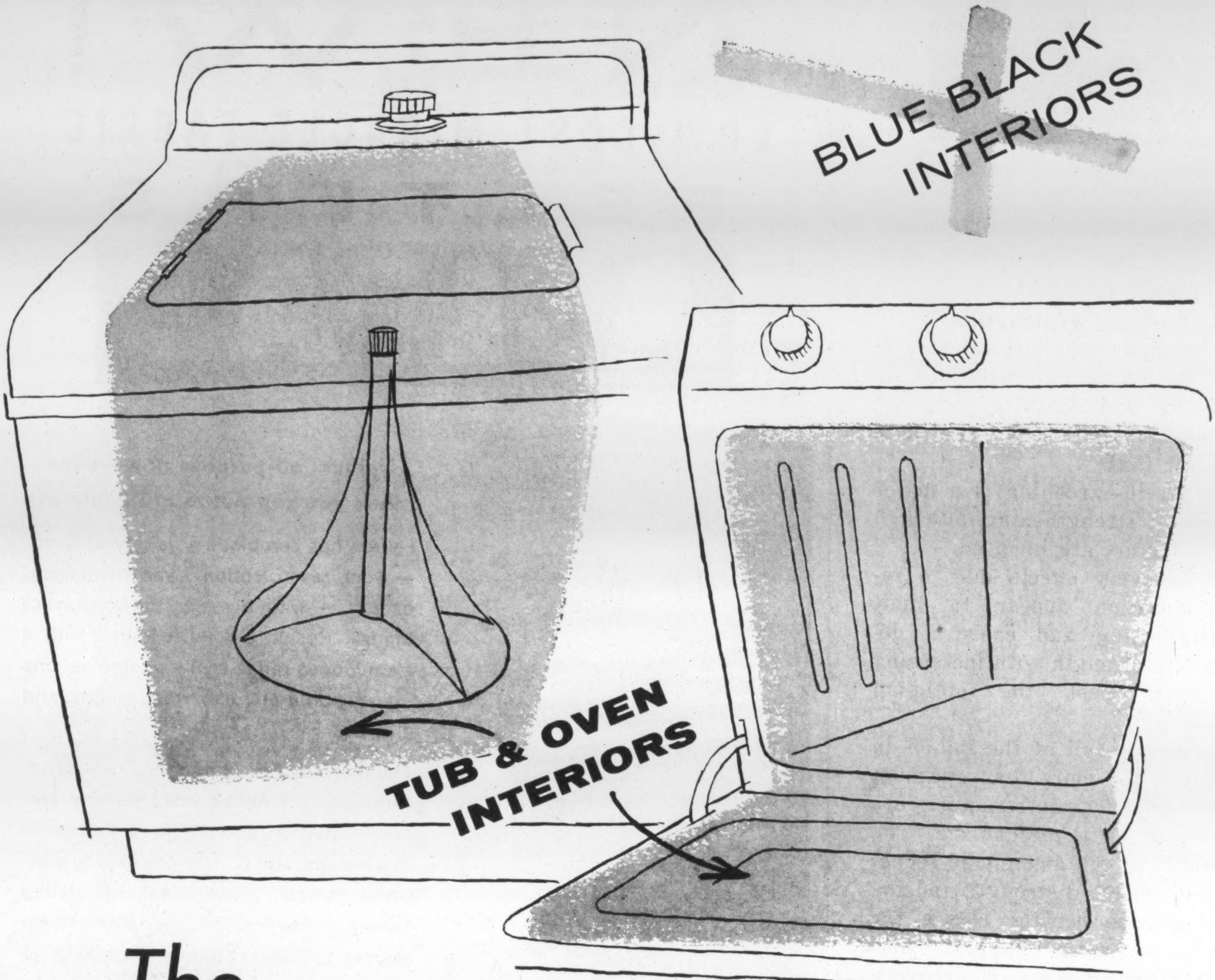

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volved in the sensitivity of strength at 1200 F to the temperature of working. This also appears to be the case for ductility in rupture tests at 1500 F.

7. If precipitation at 1600 to 2000 F does not influence strength, then maximum strengths will be nearly constant. Maximum rupture strengths at 1500 F are independent of temperature of working from 1600 to 2200 F but do not occur at constant reduction.

8. Working over a falling temperature range permits an increase in the amount of hardening and strengthening at 1200 F for a given degree of reduction at the finishing temperature when recrystallization occurs at the higher working temperatures. If reductions are kept small at all temperatures so that recrystallization does not occur, the strengthening at 1200 F, from limited reduction, appears to become additive. The weakening component appears to remain constant as a function of degree of reduction.

Small Sulfur Addition Gives Better Tool Steel

By adding 0.10% sulfur to its steel analysis, Allegheny Ludlum Steel Corp. has come up with a new tool steel claimed to possess better machinability and finish than conventional tool steels. Called Oilgraph-EZ, the new tool steel is being used for punches; gages; dies for forming, blanking and trimming; arbors; and many other parts.

In explaining the action of sul-

COMPOSITION OF OILGRAPH-EZ, %

Carbon (total)	1.45
Manganese	0.80
Silicon	1.15
Chromium	0.20
Molybdenum	0.25
Sulfur	0.10
Graphite	0.20-0.40

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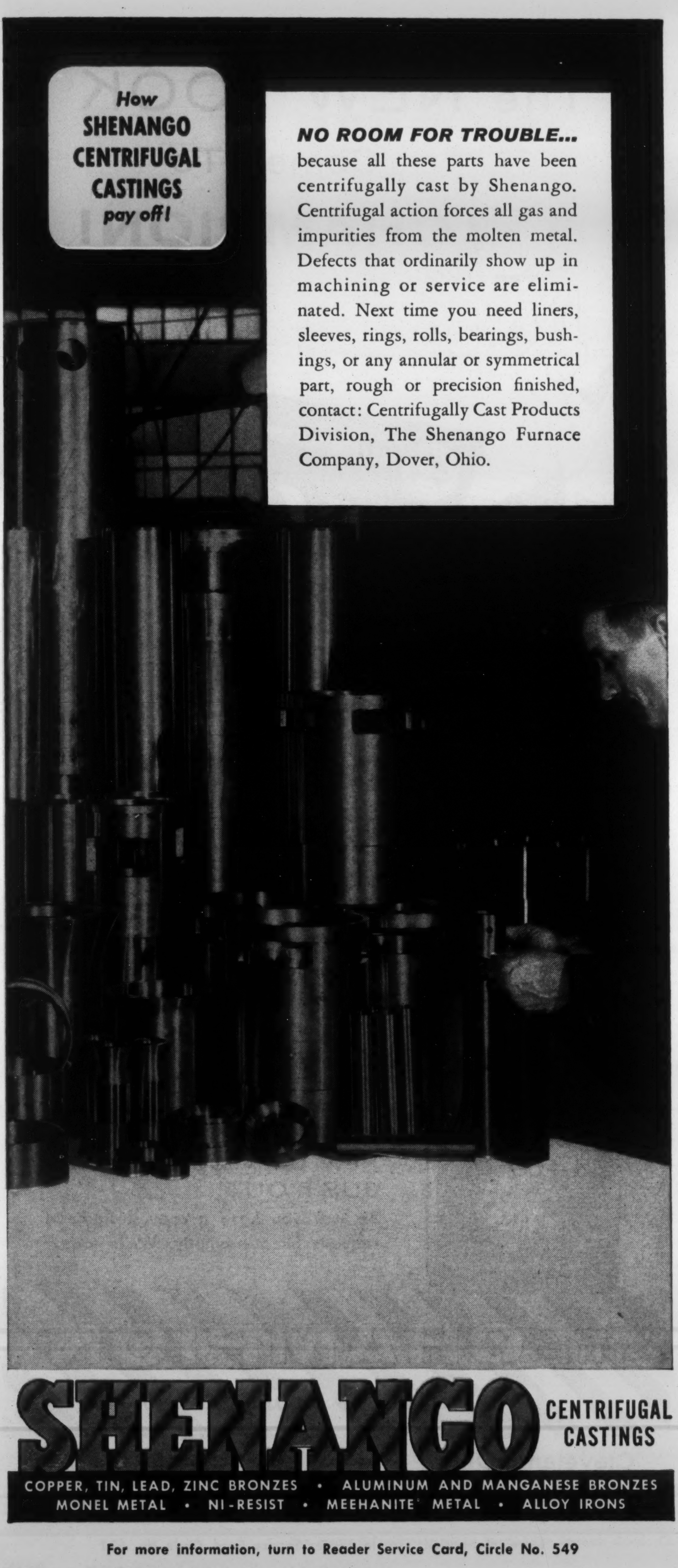

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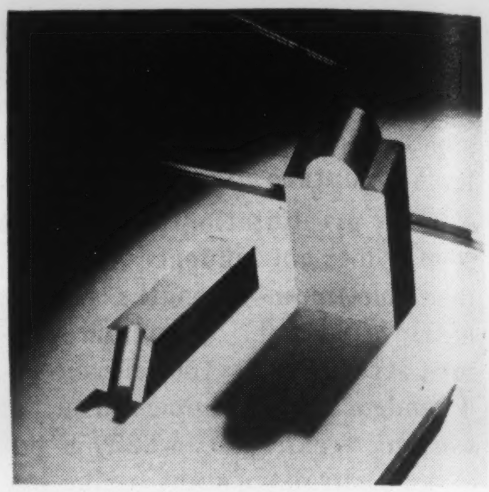


Tool steel *has excellent machinability, good finish characteristics.*

fur on the steel, Allegheny Ludlum says that although graphite in steel makes the steel easier to machine, graphite beyond 0.50% adversely affects the finish. By adding 0.10% sulfur to Oilgraph-EZ, which has a graphite range of from 0.20 to 0.40%, the graphite and sulfur act as if the graphite range were 0.50 to 0.70%. This makes the steel unusually easy to machine yet it retains its good finish characteristics.

The new steel is now commercially available and can be obtained in bars and bar stock.

Data on Hot Strength of Aluminum Alloys

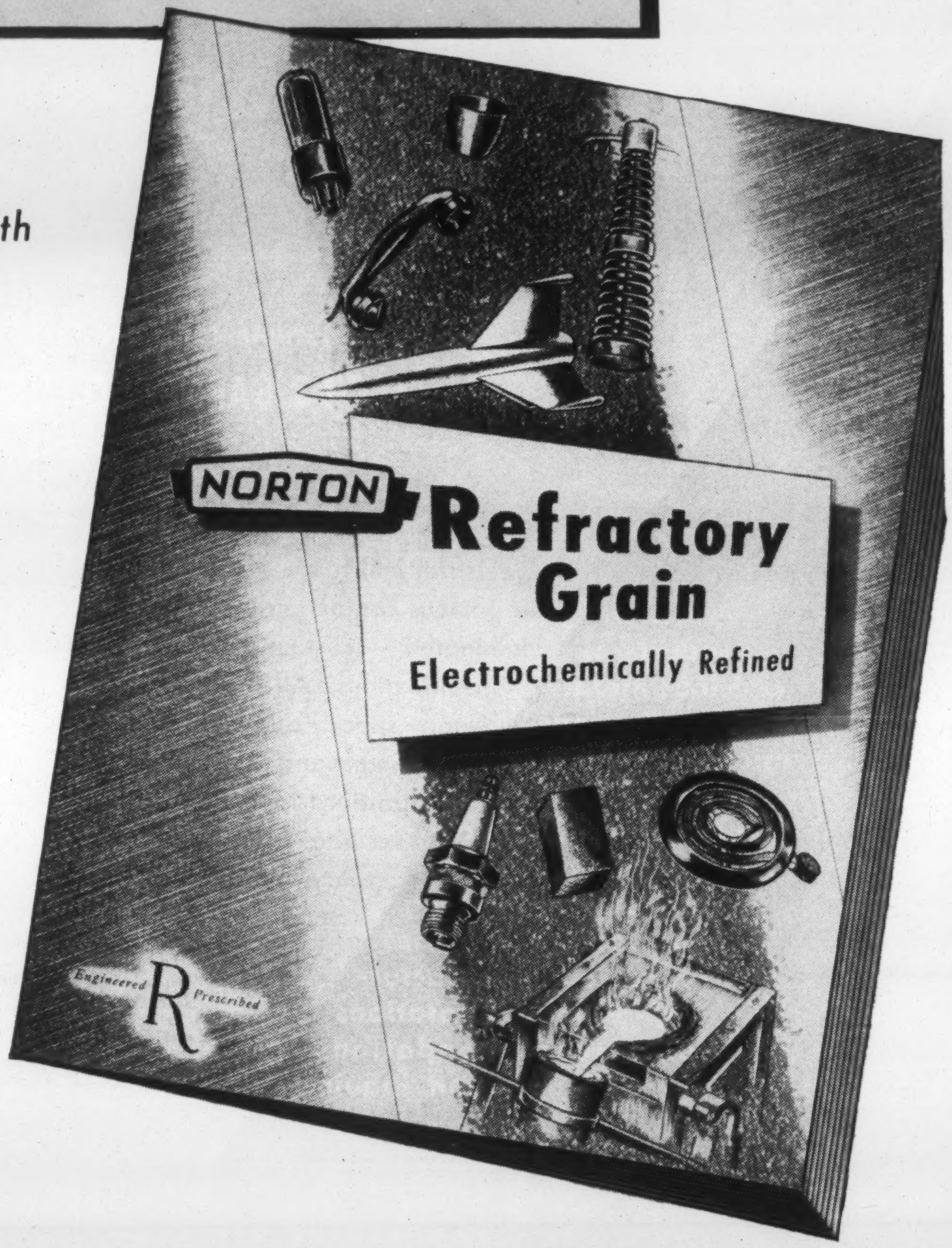
Although many studies have been made to determine the effects of elevated temperature and exposure time on the compressive stress-strain properties of 2024-T3 and 7075-T6 aluminum alloy sheet, no data are available on the effects of short exposure times (less than ½ hr) on the elevated temperature compressive properties of these alloys. In addition, compressive stress-strain data for longer exposure times are available only for temperature increments of about 100 F. In a recent investigation, Eldon E. Mathauser, of the National Advisory Committee for Aeronautics, uncovered new data on the effects of

You May Profit From This Book

✓ *if you are concerned with processing that involves temperatures ranging upwards to 4000°*

✓ *if your progress in processing depends upon materials of high purity.*

✓ *if it would help you to obtain a modern material with unusual electrical characteristics.*



Here is a valuable reference book that tells you all about the chemical and physical characteristics of such materials as CRYSTOLON* Silicon Carbide, ALUNDUM* Aluminum Oxide, MAGNORITE* Magnesium Oxide, Fused Zirconia and Boron Carbide.

Describing how these electrochemically refined materials react under varying conditions, this book gives you plenty of facts on materials that are helping to solve processing problems.

Get this useful help towards solving your own processing problems. Write today for your free copy of "Norton Refractory Grain." NORTON COMPANY, Refractories Division, 344 New Bond Street, Worcester 6, Mass.

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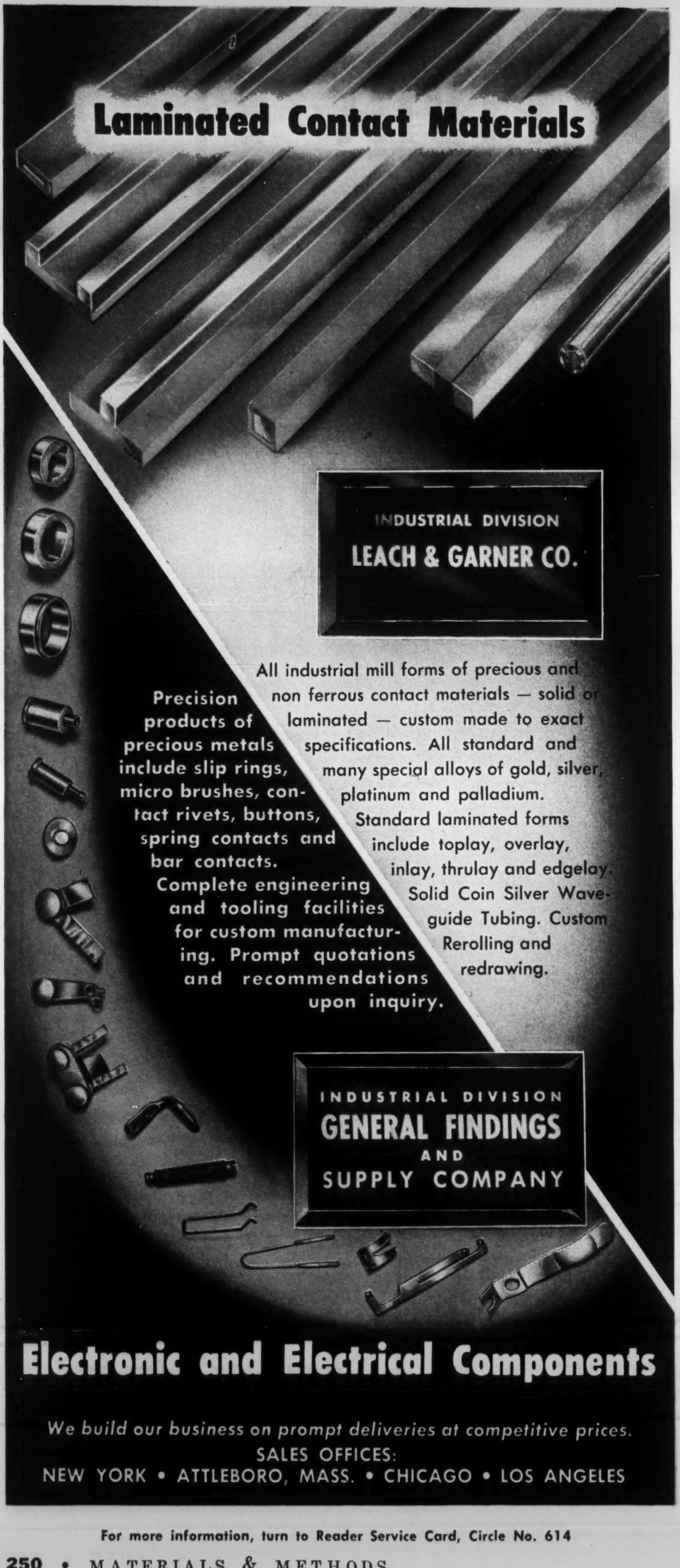
BOOTH 526—DESIGN ENGINEERING SHOW—WILL DISPLAY . . .



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short exposure times on compressive stress-strain properties of aluminum alloy sheet, as well as stress-strain curves for longer exposure times (up to 100 hr) at small temperature increments.

The data—summarized

2024-T3—Exposure times ranging from 0.1 to 100 hr produce no significant change in compressive yield stress for temperatures up to 250 F. At 300 F the compressive yield stress is not changed significantly until after an exposure of 10 hr. From 350 to 425 F, compressive yield strength increases, as a result of artificial aging, to a maximum value at different exposure times which depend upon the temperature. From 425 to 700 F, compressive yield stress for each temperature is maximum at the shortest exposure time.

7075-T6 — Compressive yield stress decreases with increasing temperature, and the highest value of compressive yield stress is obtained for the shortest exposure time at each temperature. For exposure times from 0.1 to 100 hr, the changes in compressive yield stress with exposure time are not significant up to 300 F or at 700 F. For temperatures between 350 and 600 F, substantial changes occur.

In neither alloys do significant changes in Young's modulus occur with different exposure times at any given temperature.

Mylar Film Bonded to Steel, Aluminum

Seiberling Rubber Co., 345 Fifteenth St., N.W., Barberton, Ohio, is producing a line of Mylar covered materials that can be drawn, stamped, shaped, nailed, drilled and sawed without damaging or chipping the surface of the film. The Mylar film is bonded to a variety of rigid and flexible ma-

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chem-o-sol® unlimited

TECHNICAL DATA

Chem-o-sol is supplied as a liquid and when fused at temperatures in the vicinity of 350°F. (some lower fusing compounds are available) results in a tough, resilient solid with all the outstanding physical and chemical properties associated with the polyvinyl chloride resins on which Chem-o-sol is based. Listed below are some of the properties which are available in Chem-o-sol in almost any combination:

COLOR
Available in any desired color.

TENSILE STRENGTH
As required within the range 1,000 psi. to 2700 psi.*

PERCENT ELONGATION
350 to 600*

HARDNESS (Shore A_2)
As required within the range 10 to 100.

FLEXIBILITY
A fused section of Chem-o-sol is flexible at temperatures as low as —65°F.

CHEMICAL RESISTANCE
Highly resistant to most acids, alkalies, detergents, and to a wide range of oils and solvents.

HEAT RESISTANCE
Equivalent to other versions of vinyl based compounds. Chem-o-sol, with resistance to temperature of 225°F. for as long as 2000 hours and to temperature of 450°F. for over two hours is available.

DIELECTRIC STRENGTH
Minimum of 400 volts per mil when fused in sections 3 mils thick and over.

SOLIDS CONTENT
100% — Chem-o-sol can be molded in very thick sections. Reproduction of mold surface is excellent.

APPLICABILITY
Chem-o-sol is readily applied by dipping, die wiping, molding, casting, spraying, or spreader coating.

VISCOSITY
As required for application method.

**As measured by Model IP-4 Scott Tester.*

Send For Chem-o-sol Brochure
When writing to us, use Page 10 of your chem-o-sol brochure as a guide to outline your project or new end use for Chem-o-sol. As soon as we know your requirements, our entire resources will be put to work.

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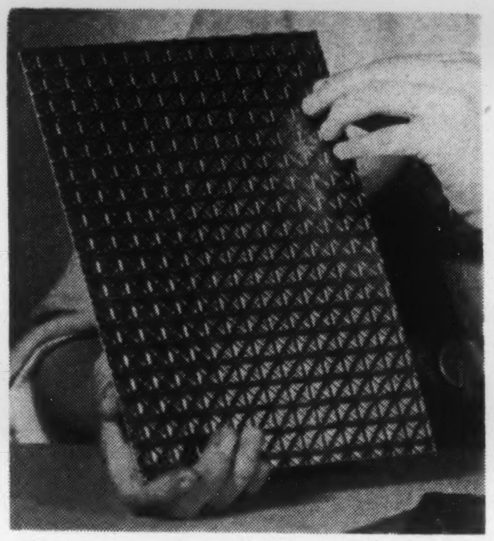
What's new IN MATERIALS



***Large patterns** with deep grooves and ridges are possible with new process for bonding Mylar film to metals, plastics and wood.*

terials with a new bonding process developed by the company.

Among the materials Seiberling is bonding with Mylar are metals of all types, including steel and aluminum, wallboard, pressed wood and flexible and rigid plastics and paper.

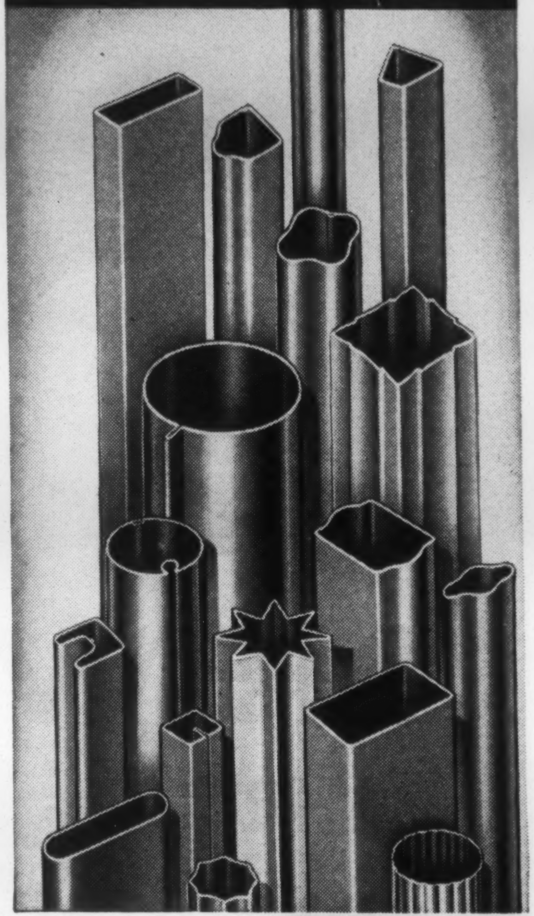
Applications for Mylar bonded materials include coverings for radio cabinets, refrigerators and air conditioners as well as trim for dash panels and other automotive fixtures.

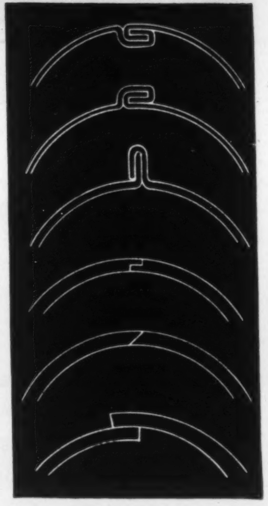
Coating for Brass Prevents Tarnishing

Brasslyfe, a protective coating for brass parts, is said to prevent tarnishing and finger stains from appearing on brass parts after they have been packaged and shipped. Introduced by Logo, Inc., 12933 South Stony Island Ave., Chicago 33, Ill., the coating is said to be hard, tough, durable and weather resistant. Sprayed, dipped or brushed on brass parts in one application, it requires no baking system. Although chemical reactions continue for several days, the producer claims that parts can be packaged and shipped within an hour after application.

(more What's New on p 255)

COLD ROLL FORMING TUBULAR SHAPES





Among the wide variety of things you can make on a Yoder Cold Roll Forming machine are round, square, oval, rectangular and other tubular shapes, such as illustrated. The seams may be open, lapped, butted, dovetailed, interlocking, etc.—as shown in the drawing.

Millions of feet of such unwelded tubular shapes are made from coiled strip for conductor pipe, bedsteads, lamp stands, window channel, wiring raceways, carrying rods, etc. Production ranges from 20,000 to 50,000 feet per day, with only one operator and a helper.

Yoder offers you the cooperation of their engineering staff for designing and adapting their cold roll forming machines, auxiliaries, and tooling, for the low cost production of structurals, mouldings and trim, panels, tubular and other shapes, to meet individual needs.

The Yoder Book on Cold Roll Forming is a complete, illustrated text on the art and the equipment needed for performing a variety of operations which can be combined with cold roll forming, at little or no extra labor cost. A copy is yours for the asking.

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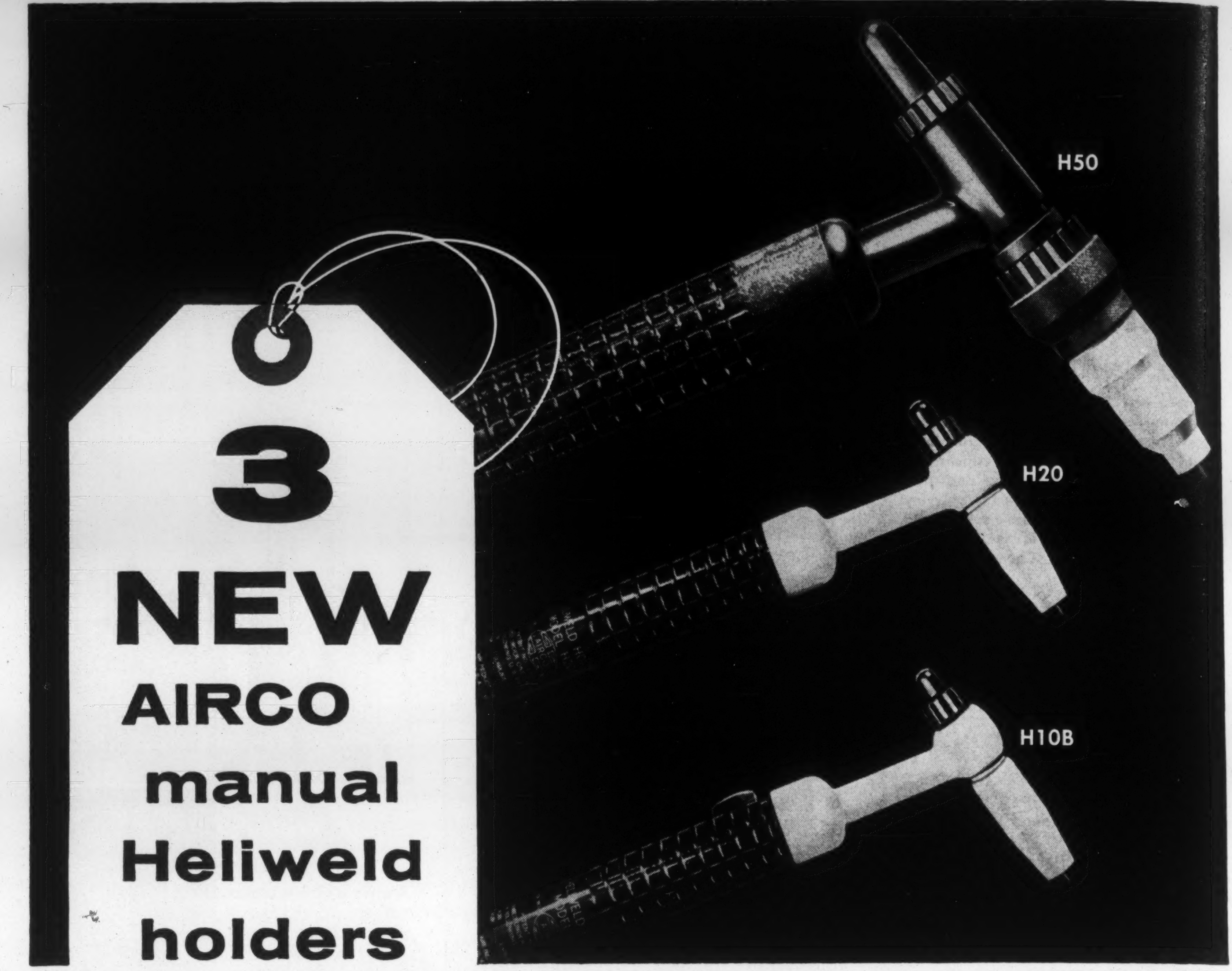
YODER ENGINEERING MANUFACTURING
COLD-ROLL FORMING MACHINES

For more information, Circle No. 434



3 NEW AIRCO manual Heliweld holders

for greater flexibility in tungsten arc welding

Wider and higher current ranges of these three new Heliweld holders add a new measure of versatility in the welding of thin gauge sheet aluminum, stainless steel, copper base alloys, magnesium and killed steel.

Water-cooled H50 Heliweld holder has a continuous duty rating of 500 amps DC and 350 amps AC. New nozzle and holder design provides efficient gas coverage at reduced gas flow . . . costs less to operate. Stub loss only 1¼". Parts interchangeable with M50 machine holder.

Water-cooled H20 Heliweld holder has a continuous duty rating of 200 amps, AC or DC, yet is only 7¾ inches long; weighs 4 ounces. Compactness of the welding head makes the H20 ideal for welding in tight corners. Parts interchangeable with the H10.

H10A and H10B Heliweld holders, both air-cooled, have continuous duty ratings of 100 amps, AC or DC. The H10B holder is the *only* unit on the market that has a thumb-operated gas valve on the handle for greater gas savings.

For complete information consult your nearest Airco Office or Authorized Airco Dealer.

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For more information, turn to Reader Service Card, Circle No. 481

New Theory May Give Stronger Laminates

Stronger reinforced plastics may result from development of a series of mathematical formulas for calculating the strength of discontinuous glass fiber-reinforced thermosetting resins. In molding glass-reinforced thermosetting plastics the resin shrinks as it cures and causes pressure between the resin and the reinforcing fiber. The pressure causes a build up of frictional force that loads the fiber. This pressure between resin and fiber seems to be a governing factor in mathematically predicting the properties of reinforced plastics.

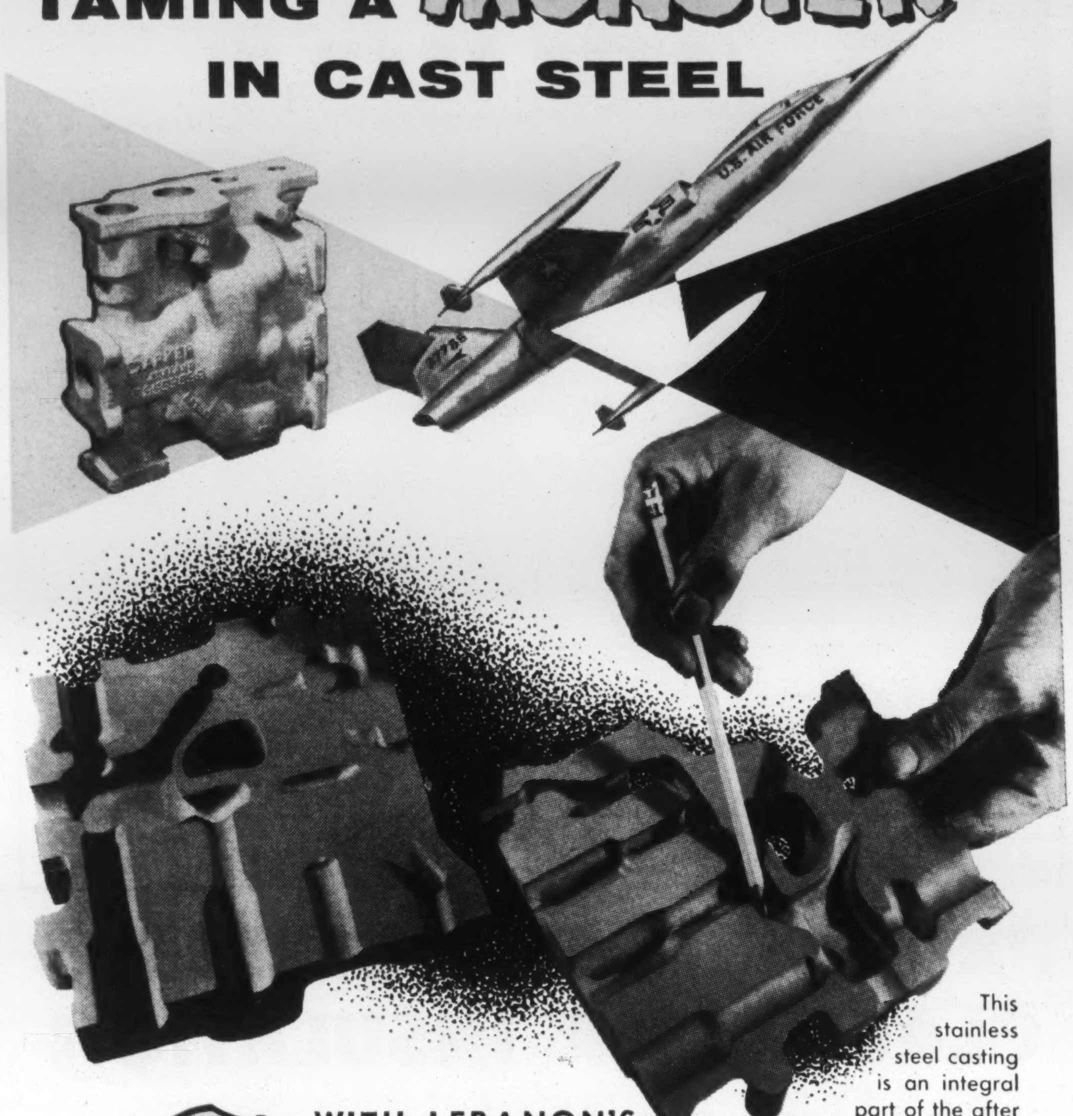
This fact was demonstrated at a recent meeting of the American Society of Mechanical Engineers where J. O. Outwater, Jr., of the University of Vermont, presented a series of mathematical formulas showing that 85 to 90% of the tensile strength of laminates is due to frictional resistance between fiber and resin when the resin shrinks against the fiber during cure; the other 10 to 15% of the tensile strength is contributed by primary adhesion between glass and resin.

It seems from this that primary adhesion, which usually is regarded as the governing factor in explaining the behavior of reinforced plastics, does not fully explain the mechanism of reinforcement.

Tests prove theory

A series of controlled experiments were undertaken to prove the mathematical formulas. Tensile tests were performed on a standard 2-in., glass reinforced polyester resin. The specimens were loaded in tension, unloaded and subsequently pulled to failure.

In comparing the predicted behavior of the mathematical formulas with that of actual experimental data a marked similarity was noted in the following ways: 1) stress-strain relationship is



TAMING A "MONSTER" IN CAST STEEL

This stainless steel casting is an integral part of the after burner of a jet engine. The close-up illustrates the casting cut in half immediately after foundry production, before any machining.

WITH LEBANON'S CERAMICAST* PROCESS

THIS FLOW DIVIDER AND FUEL SELECTOR FOR A JET ENGINE was called the "monster" by its designers at the Cleveland Division of Parker Aircraft Company. Why? Because the dimensional requirements of its inner passages called for the most extreme quality control in the casting process.

Foundry engineers at Lebanon met the challenge, and selected the CERAMICAST Process as best suited because of the need for close tolerances, extreme smoothness in the internal passages, and the intricate coring.

During several months of development work, Lebanon engineered a special coring material to meet these requirements and developed special gauges for setting and holding the cores to meet the dimensional tolerances. Now in quantity production at Lebanon, this aircraft casting meets Class I X-ray inspection and operates under service conditions of high pressures and elevated temperatures.

LET US TAME YOUR "MONSTER" If your design project utilizes cast steel and requires a high degree of internal casting quality together with surface smoothness, close tolerances, and dimensional accuracy, CERAMICAST may provide definite quality and cost advantages. Let our engineers discuss the process with you and its applicability to your project. Write for CERAMICAST literature.

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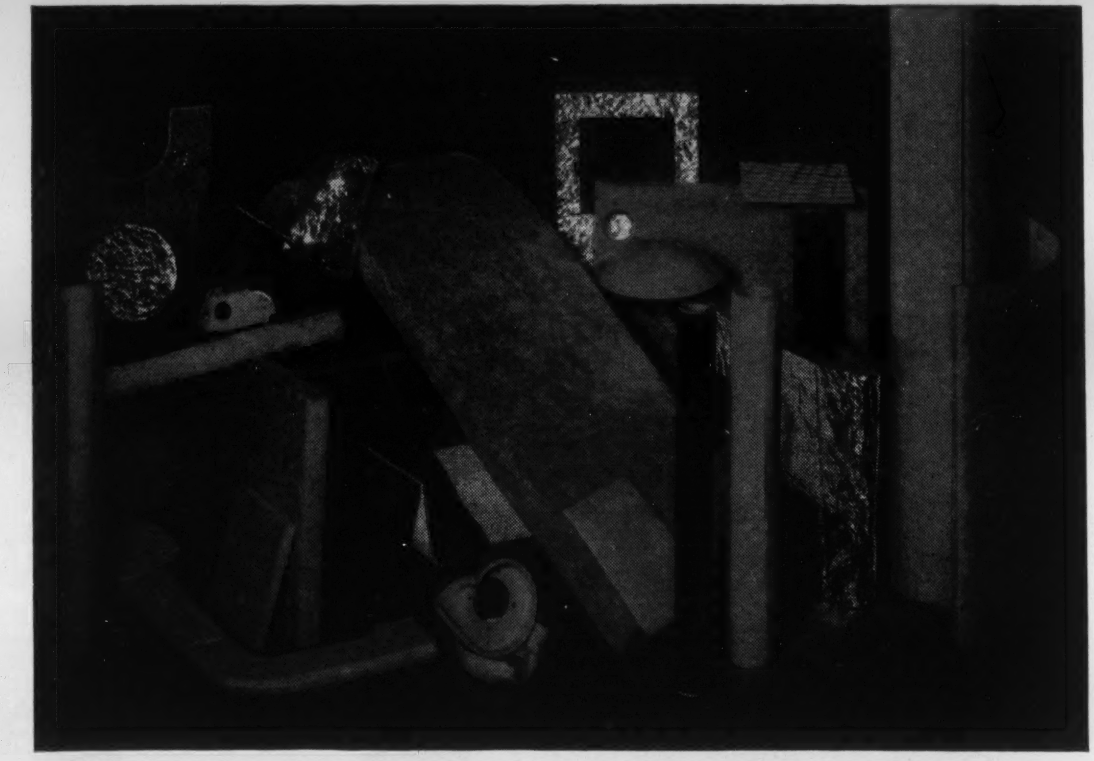

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linear until primary adhesion is broken; 2) when primary adhesive bond is broken there is a sudden change in the stress-strain curve which is probably due to the position of the fibers in the laminate (in the actual specimen a distinct audible creaking was heard); 3) extension of the stress-strain curve increases with the load, but modulus decreases as the load increases; 4) permanent set takes place in the specimen when load is removed at a point prior to failure—probably due to the fact that the fiber ends do not return to their original position; 5) the new stress-strain curve rejoins the original curve on reloading and continues smoothly until sudden failure.

How to improve laminates

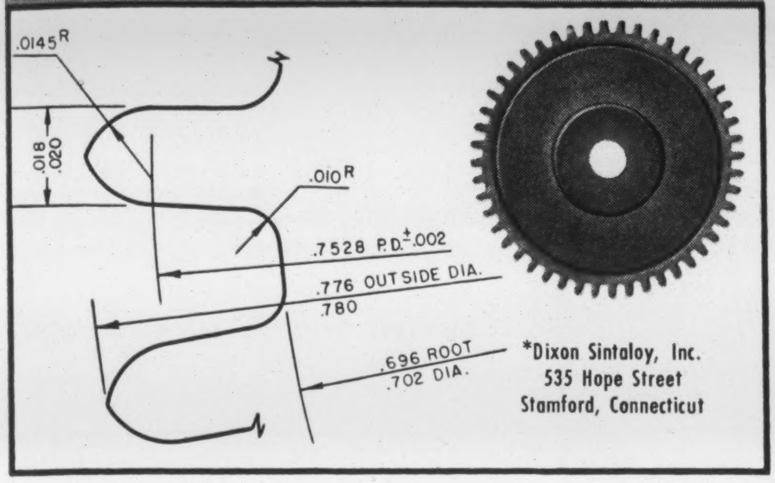
The mathematical formulas suggest two methods of improving the properties of reinforced plastics. One suggests the use of a very thin layer (0.00001 in. thick) of low modulus material to act as a cushion between the resin and the fiber. This may raise the value of load where the bend occurs in the stress-strain curve and increase the over-all modulus of the material. The second method suggests the use of a low shrink resin to reduce internal stresses that may cause cracking of the fibers and resin.

Ni-Cr-B Brazing Alloy Solves Joining Problem

Use of a nickel-chromium-boron high-temperature brazing alloy has solved the problem of brazed joint separation in the manufacture of bi-metallic hydraulic manifolds for guided missile applications. The brazing alloy, known as Nicrobraz and developed by Wall Colmonoy Corp., is said to resist separation during processing which involves a bonding bath and temperatures of 1300 F.

The hydraulic manifold is composed of a cluster of steel tubes

BRASS GEARS
PRESSED FROM POWDER



*Dixon Sintaloy, Inc.
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. . . not only save money in manufacturing costs at the Marvel-Schebler Products Division of the Borg-Warner Corporation, but they are made dimensionally accurate to very close tolerances by its supplier* of brass powder parts.

Alternative methods of production involve scrap loss, machining time and expensive bar stock. On the other hand, as pressed and sintered from 80–20 leaded brass, the gear requires no secondary operations, involves no scrap loss, is accurate and durable.

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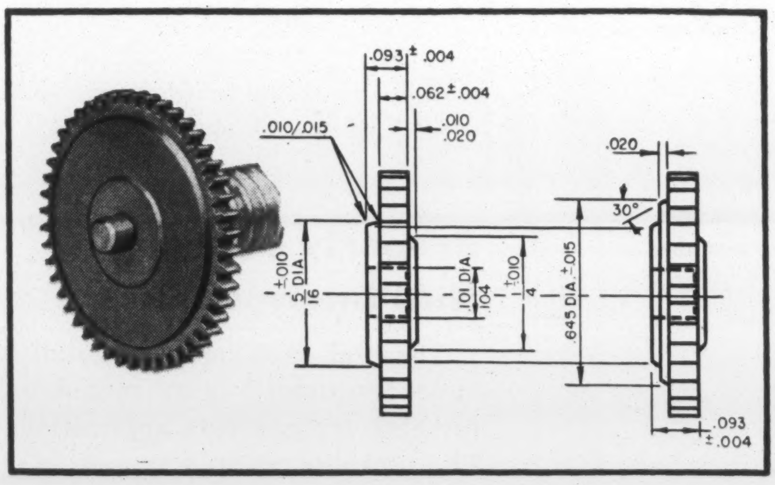
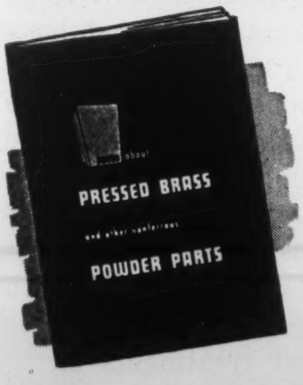


What can BRASS POWDER PARTS do for you?



For detailed information on the design, properties, production and application of brass and other nonferrous powder parts you should have a copy of our manual. It will give you 20 case histories of brass and nickel silver powder structural parts to assist in evaluating this means of production in terms of your particular needs.

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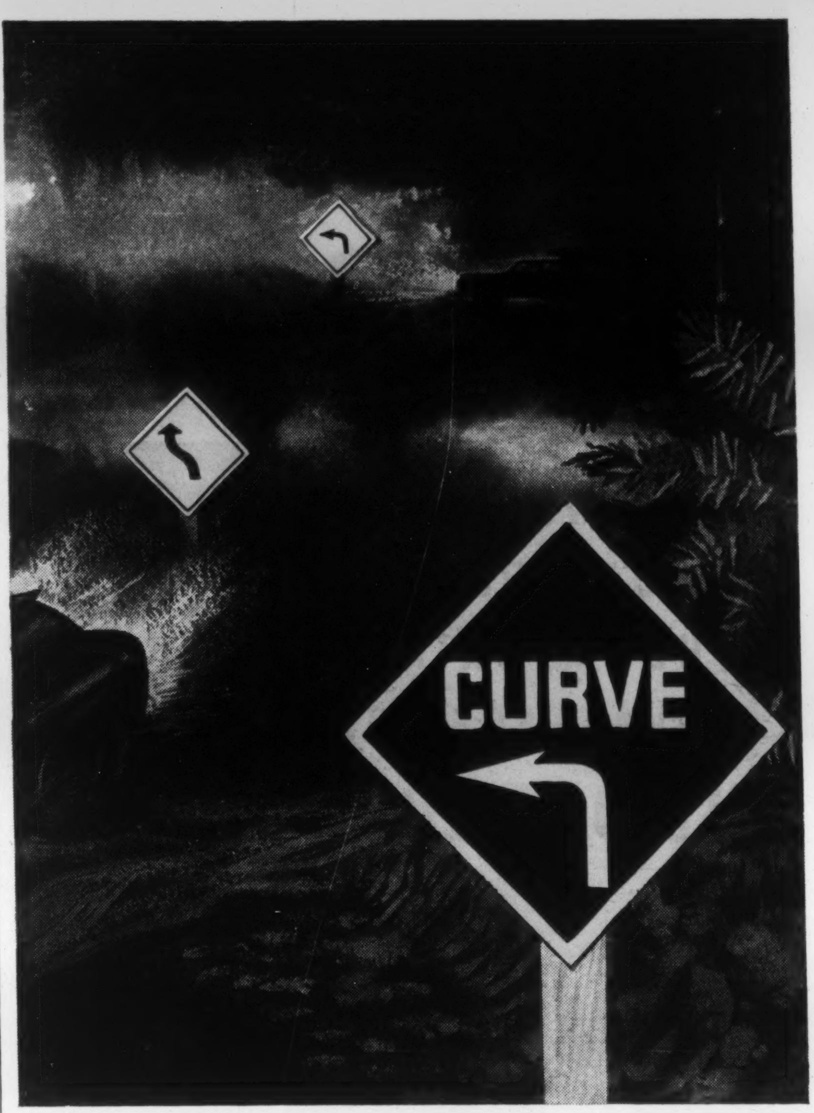

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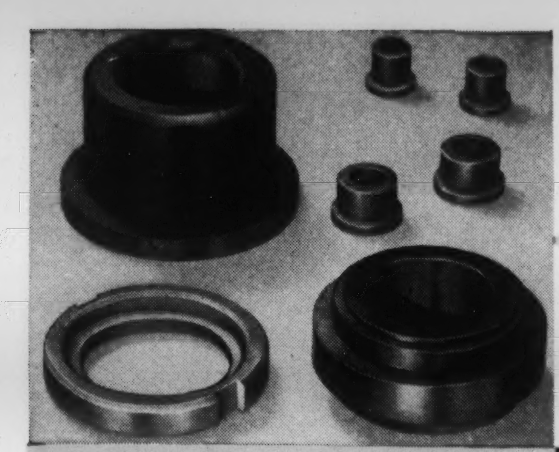

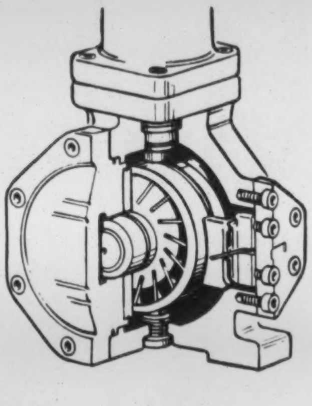

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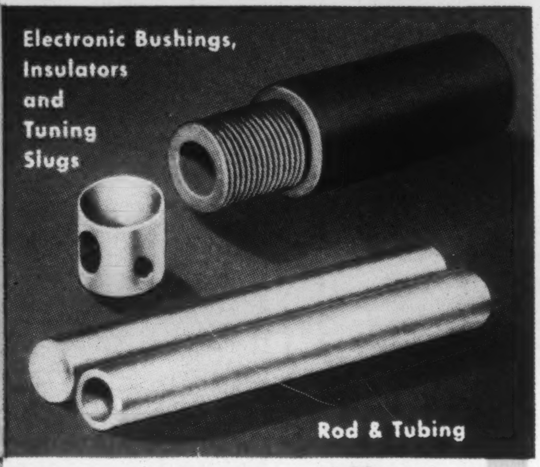

Electronic Bushings,
Insulators
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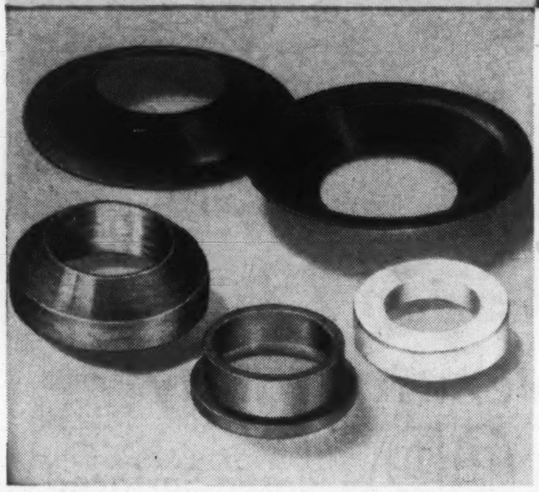
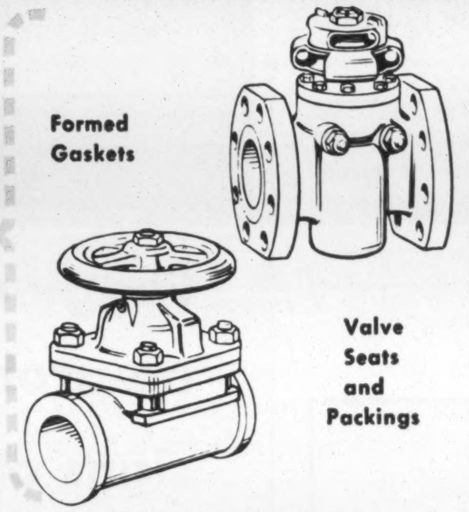
Tuning
Slugs

Rod & Tubing





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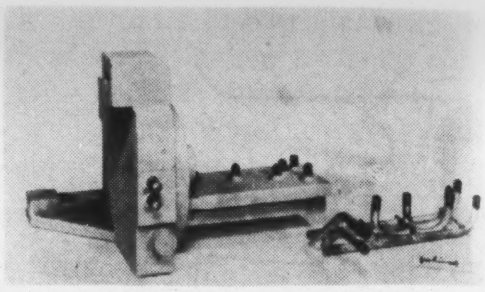

***Special brazing alloy** is required for fabrication of manifold.*

cast into a magnesium housing (see photo). Four ¼-in. stainless steel tubes are first positioned and brazed in place and reinforced with ⅛-in. drill rod cross members to form a rigid, dimensionally stable assembly. The tube assembly is then given a bonding bath and cast into the magnesium housing.

Copper brazing cannot be used in this application because of copper's high solubility in the the bonding bath which results in separation of the brazed joint. Fabrication by welding is difficult because of the tendency of thin walled members to fracture when joined to the thicker sections.

Property Data on NiAl Intermetallics

The high melting intermetallics have frequently been considered for high temperature applications. The nickel-aluminum system is of special interest because compositions of this type prepared by powder metallurgy have been reported to possess good modulus of rupture up to 1800 F and excellent oxidation resistance up to 2000 F.

Now, a better understanding of these materials is possible as a result of work by Edward M. Grala, of Lewis Flight Propulsion Laboratory, who has studied the effects of composition and homogenization heat treatments on the hardness and tensile properties of nickel-aluminum intermetallics.

Mr. Grala finds that relatively small changes in composition within the NiAl phase result in ap-

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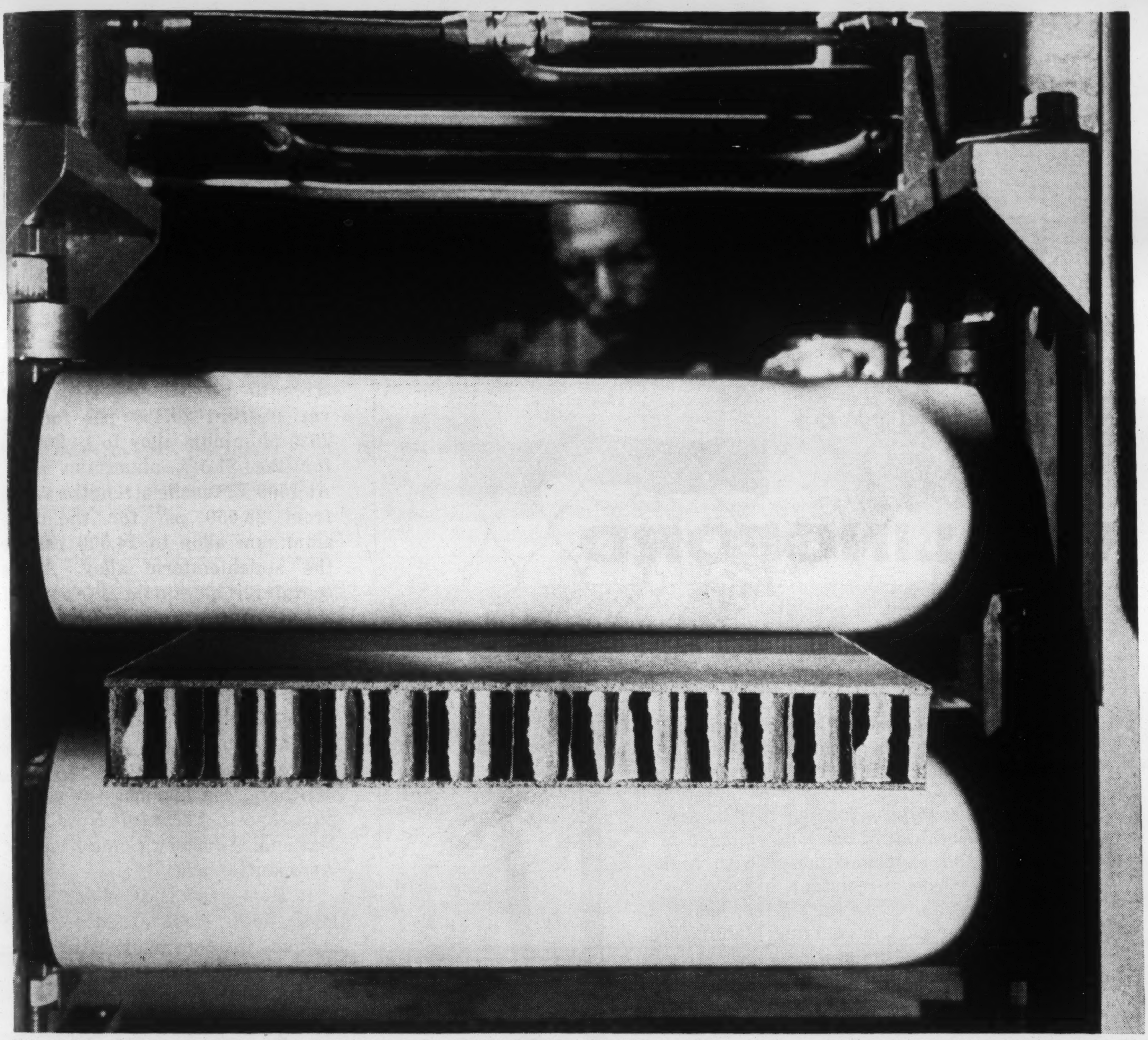

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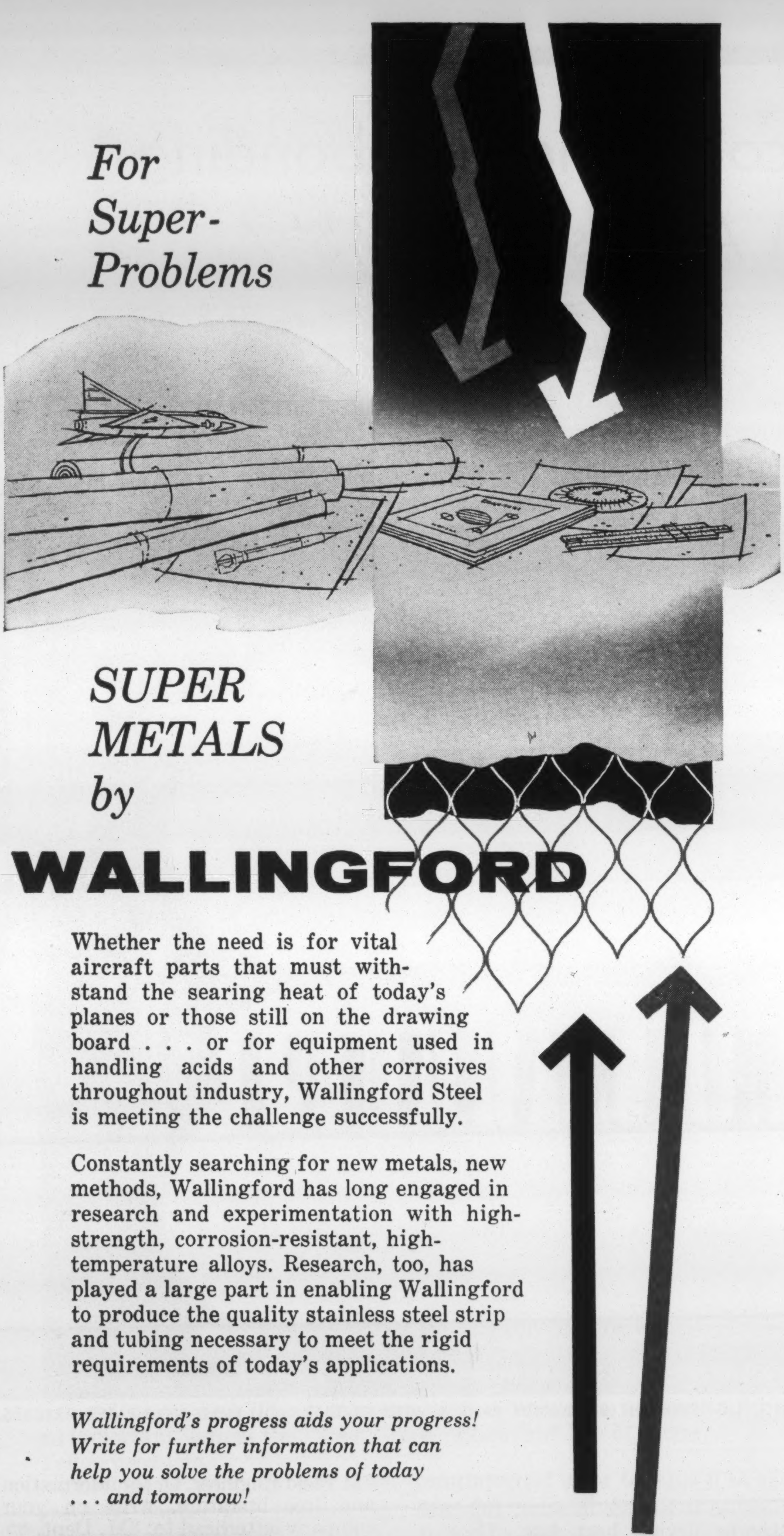

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preciable changes in the mechanical properties of these alloys. Hardness at room temperature decreases with increasing aluminum content up to the stoichiometric composition (31.5% Al) then increases rapidly with further aluminum additions. Room temperature tensile strength of both as-cast and homogenized alloys, and tensile strength at 1500 F, of homogenized alloys also decrease with increasing aluminum content up to the stoichiometric composition. For example, room temperature tensile strength of homogenized alloys varies from 29,450 psi for the 25% aluminum alloy to 14,900 psi for the 31.5% aluminum alloy. At 1500 F, tensile strengths range from 29,050 psi for the 25% aluminum alloy to 14,500 psi for the stoichiomteric alloy. Alloys containing aluminum in excess of the stoichiometric value have poor tensile properties.

None of the alloys shows any room temperature ductility. At 1500 F, alloys containing up to 31.5% aluminum exhibit considerable tensile ductility.

Other conclusions, originally published in *Technical Note* 3828, National Advisory Committee for Aeronautics, are:

1. Homogenization of as-cast alloys does not produce large changes in room temperature tensile strength. Small increases or decreases occur, however, depending on the alloy's composition.
2. Stoichiometric NiAl attains its highest tensile strength, 19,800 psi, at 1200 F. This is the lowest temperature at which this alloy appeared to have tensile ductility. Above 1200 F, tensile strength falls off slowly to a value of 9600 psi at 1800 F. The 100-hr rupture strength of stoichiometric NiAl is 4500 psi at 1500 F.
3. The 1500 F tensile strength of the 30% aluminum alloys is affected by heat treatment below the grain growth temperature. Although no microstructural dif-

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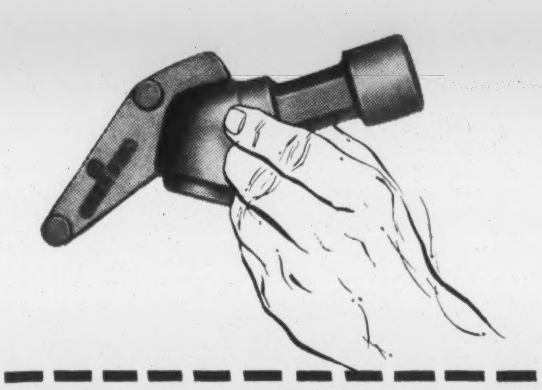

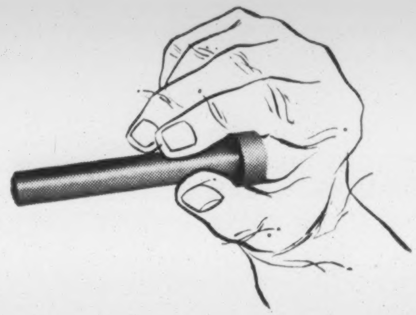

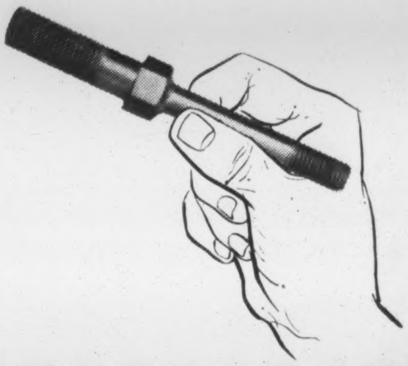

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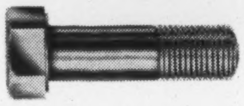

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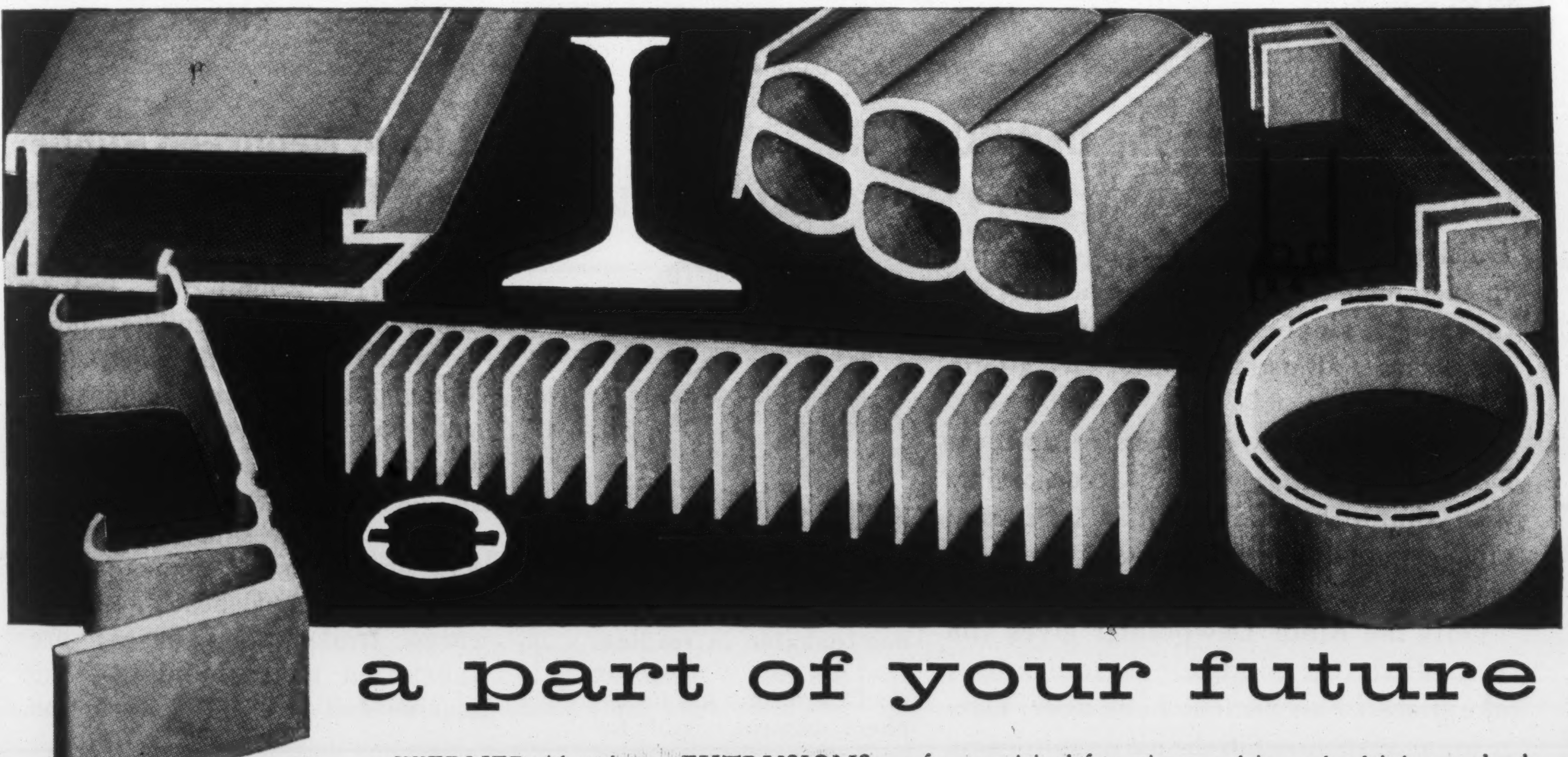

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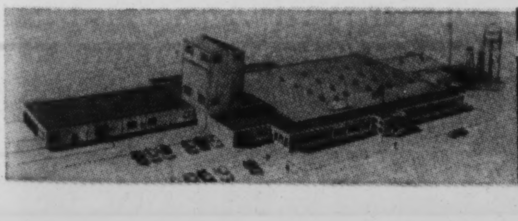

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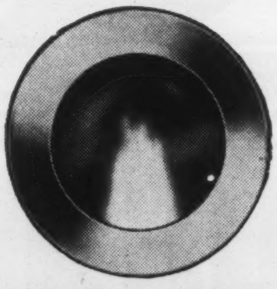

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ferences are observed, specimens homogenized at 2400 F have an average 1500 F tensile strength of 24,850 psi, compared to 16,300 psi for those homogenized at 2100 F.

4. For the 25% aluminum alloy, heat treatment (which produces grain coarsening) decreases tensile strength at both room temperature and 1500 F. The 1500 F properties decrease from 29,050 psi tensile strength and 25.9% elongation, for specimens homogenized at 2100 F, to 18,700 psi tensile strength and 0.5% elongation, for specimens given a grain coarsening heat treatment at 2400 F.

5. Additions of 0.5, 1.0 and 2.0% molybdenum to stoichiometric NiAl decrease as-cast grain size and result in appreciable increases in tensile strength and ductility at both room and elevated temperatures.

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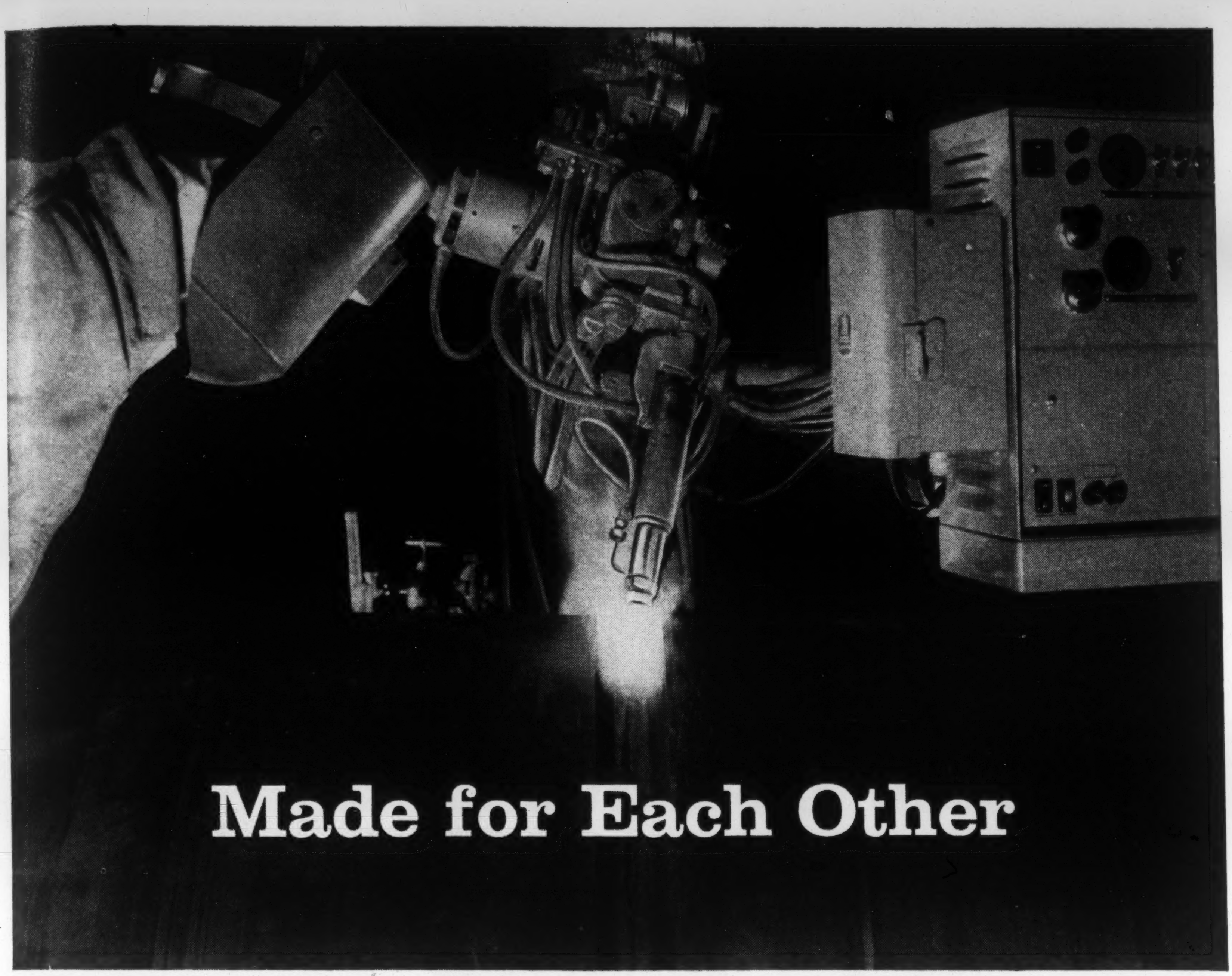
Precious Metal Alloy Offers High Resistivity

A new palladium-gold-iron alloy which offers very high resistivity plus a negative temperature coefficient of resistance, is now available for use as potentiometer wire.

Developed by Baker & Co., Inc.,



High-speed sigma welding a 5-in. thick alloy paper mill roll. Note top quality of multipass weld beads.

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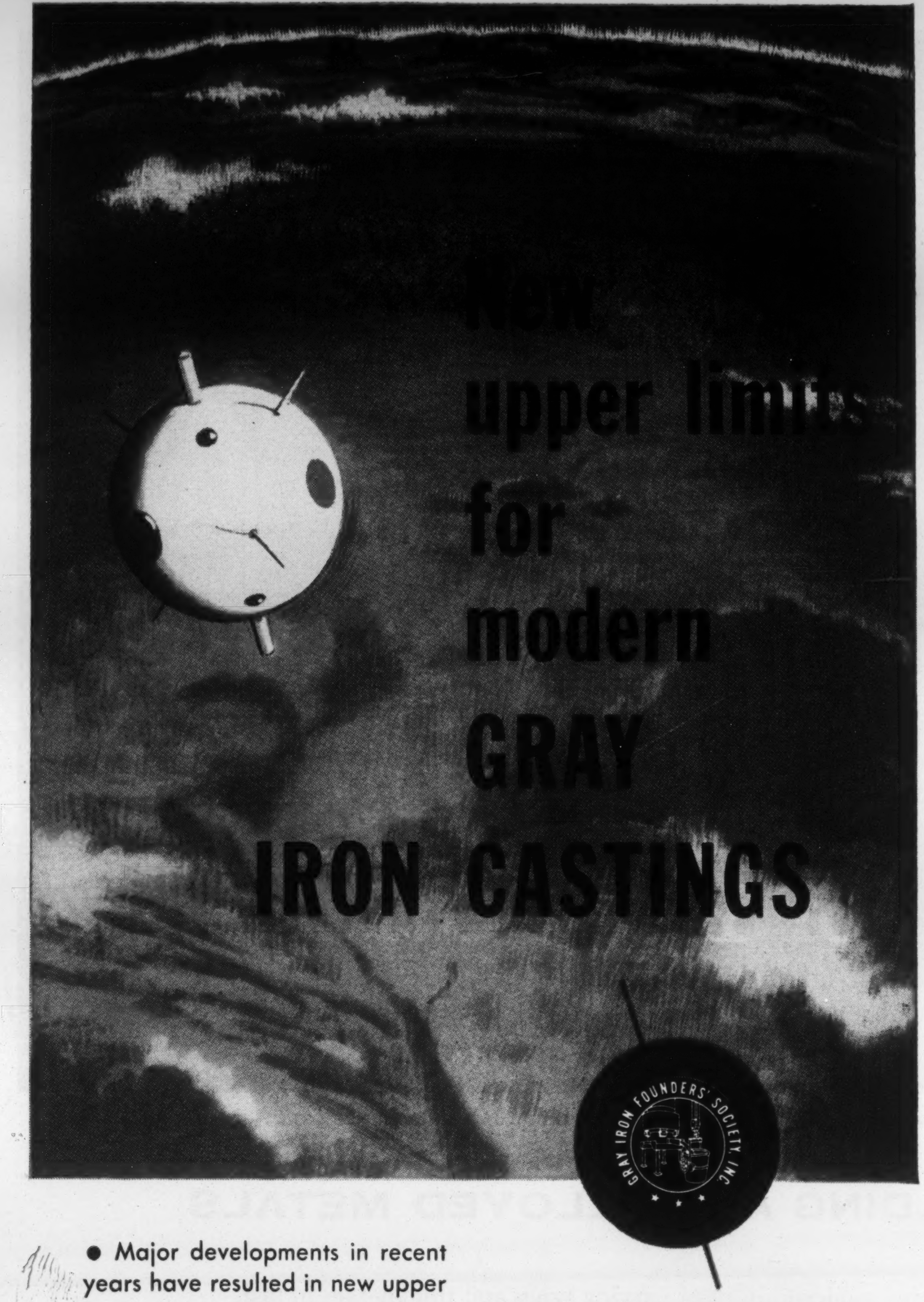

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the new alloys are making possible a number of improvements in potentiometer design. For example, the alloy's lower vulnerability to severe temperature changes makes it suitable for use in guided missile instrumentation. Also, since the high resistivity alloys permit the use of less wire, designers are able to reduce size of some instruments while retaining a given resistance. Finally, expensive fine wire can be replaced without decreasing resistance.

Effect of Cold Working on Nickel-Base Alloys

The ever-increasing demands placed on metals often necessitates a reevaluation of factors previously considered unimportant. For example, although the effect of superficial cold working caused by machining nickel-base alloys was not considered significant in older applications, it may be very influential in determining the alloy's performance in gas turbines.

The amount of cold working that can result from machining has been demonstrated by Pronkin in the Nov '56 issue of *Vestnik Mashinostroyeniya* (Russian). Broaching, which is commonly used for machining the fir-tree section of gas turbine buckets, causes a pronounced increase in the surface hardness of nickel-base alloys. For example, the microhardness of an unmachined specimen was 350/370 Vickers. The built-up edge had an average hardness of 580 Vickers and the chip was about 470. The broached surface showed 430 Vickers. The broaching operation, therefore, increases surface hardness by about 20%.

Tests to determine the significance of this factor are described by Buckle, Galmiche and Gilles in a recent issue of *Revue de Metal-*

lurgie (French). The authors point out that scaling has very little effect on these high-nickel alloys, even at the highest contemplated service temperatures. On the other hand, appreciable corrosion cracking is observed at temperatures higher than about 1380 F and, in certain cases, may result in service failures.

Specimens of nickel-base alloys in three conditions (electrolytically polished, skin annealed by holding ten minutes at 1975 F in a current of hydrogen and cold worked) were tested for 100 hr at 1650 F in the products of combustion of kerosene (with 0.5% sulfur), which were alternately oxidizing and reducing. The results show that surface cold working has a considerable influence on the penetration rate of products of corrosion. Therefore, the possibility of very pronounced local cold working by machining must be taken into consideration.

The direct relation found between the appearance of corrosion cracking and cold working emphasizes the fact that a machining groove — even if subsequently eliminated by mechanical polishing—has an effect on the subsurface and produces an accelerated change in adjacent zones. It can have a harmful effect on service life, even over and above any corrosion effect. Skin annealing does not cause any corrosion and assures some protection of treated material against the action of combustion gases at high temperatures.

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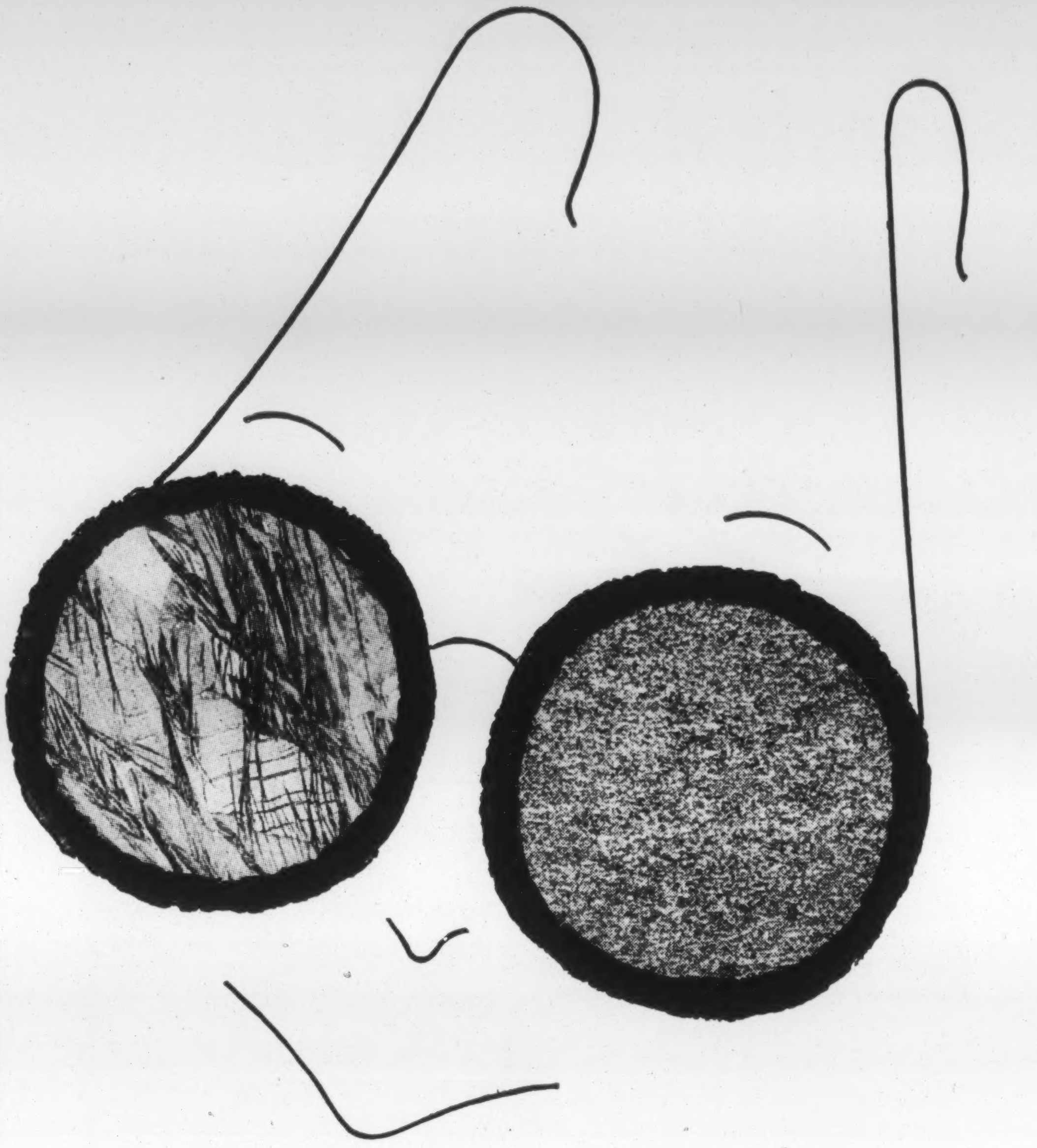
Three new patent pending, mill products made of a magnesium-silicide type aluminum alloy, have been announced by Aluminum Co. of America, 1501 Alcoa Bldg., Pittsburgh 19, Pa. The three new products, recommended for



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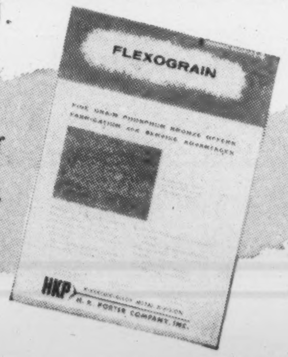

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use in the porcelain enameling industry, are an enameling sheet and two extruded shapes. They are known as No. 1 Porcelain Enameling Sheet and Nos. 1 and 2 Porcelain Enameling Extruded Shapes.

According to the company, the new aluminum shapes provide a uniformity of behavior throughout the enameling process; improve adherence of the enamel to the aluminum; permit less critical control of aluminum parts during metal surface preparation; and lower enameling costs.

New Data on Fatigue Below 10,000 Cycles

Much information has been published on the endurance limit and fatigue life of materials at stresses that produce failures in much more than 10,000 cycles. Information on fatigue tests producing failures in less than 10,000 cycles is extremely limited. Recently Walter Illg, Langley Aeronautical Laboratory, tested notched and unnotched sheet specimens of 2024-T3 and 7075-T6 aluminum alloys and SAE 4130 steel in the range between 2 and 10,000 cycles. Originally presented in *Technical Note* 3866, National Advisory Committee for Aeronautics, results of Mr. Illg's tests show that:

1. Repeated applications of stresses in the vicinity of the ultimate strength on notched and unnotched specimens produce failures in much smaller numbers of cycles than might be inferred from previously published data.
2. The ratio of the fatigue strength of unnotched specimens to that of notched specimens at the same lifetime decreases with increasing nominal stress.
3. The tensile strengths of notched specimens of 7075-T6 aluminum alloy and SAE 4130 normalized and hardened steel are higher than those of unnotched

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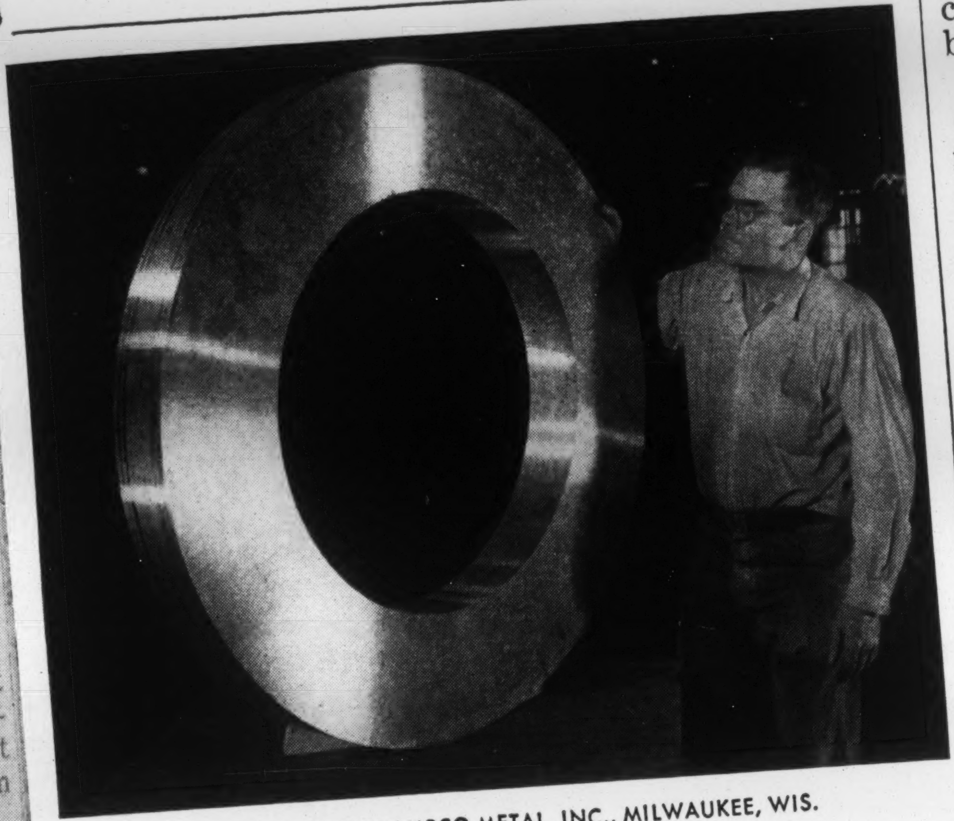
BETTER PRODUCTS SECTION



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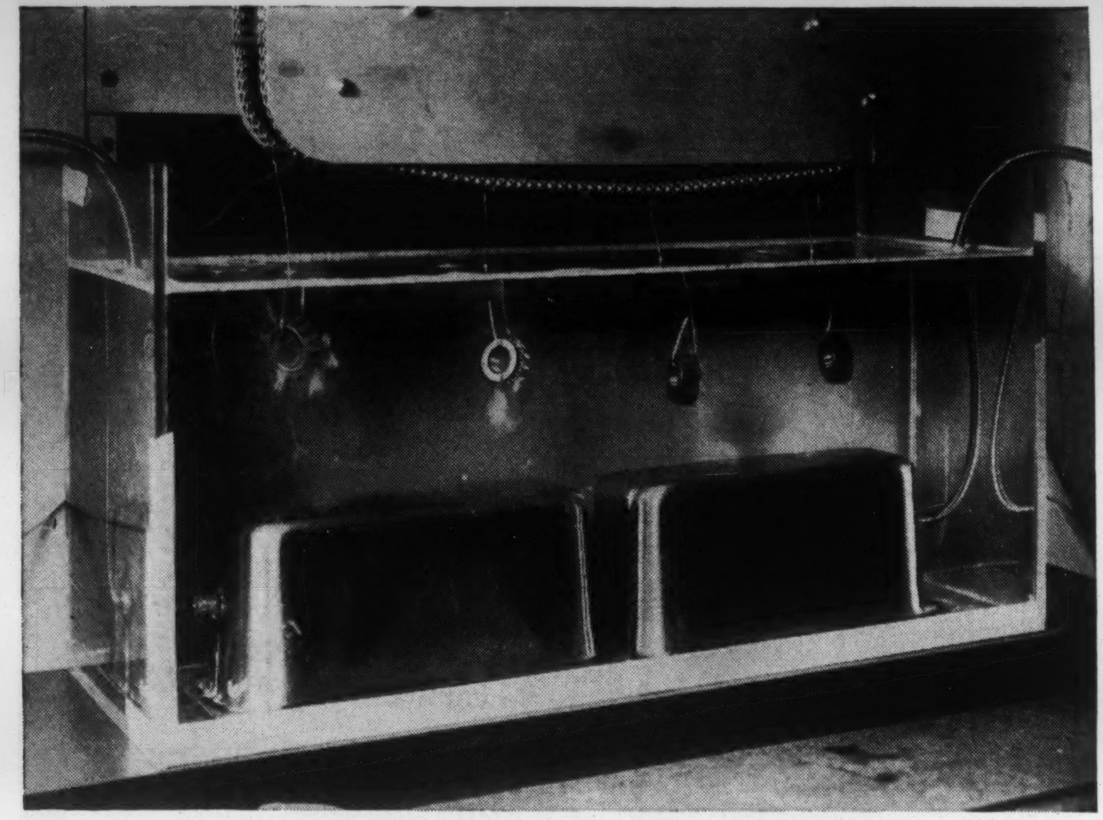

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specimens of the same materials. The reverse is true for 2024-T3 aluminum alloy.

4. There appears to be no significant difference between the test results of polished and unpolished specimens or between the test results of specimens cycled at 50 and 1800 cpm.

A New Nodular Iron

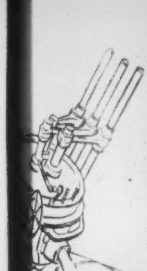
A new nodular (ductile) iron which combines the process advantages of cast iron with many of the advantages of steel, is now being made at American Meter Co.'s Reliance Foundry.

The new metal, called Relianite, is said to have cast iron's low melting point, good fluidity, castability and machinability, and steel's high strength, toughness, ductility and wear resistance. It is available in four grades: R1 offers toughness, shock resistance and maximum machinability; R2 is suitable for heavy duty machinery parts; R3 has superior wear resistance; and R4 is specially suited for high temperature applications, up to 1600 F.

Strength of Cermets vs Surface Treatment

Theoretical and experimental investigations of the effect of surface condition on the strength of various brittle materials have shown that small surface defects can radically affect strength properties. However, no such investigation has ever been reported for cermets.

Information along these lines is now available as a result of the investigation carried out by Leonard Robins and Edward Grala. As reported in *Technical Note* 3927 of the National Advisory Committee for Aeronautics, the authors felt that since cer-



Tool Steel Topics

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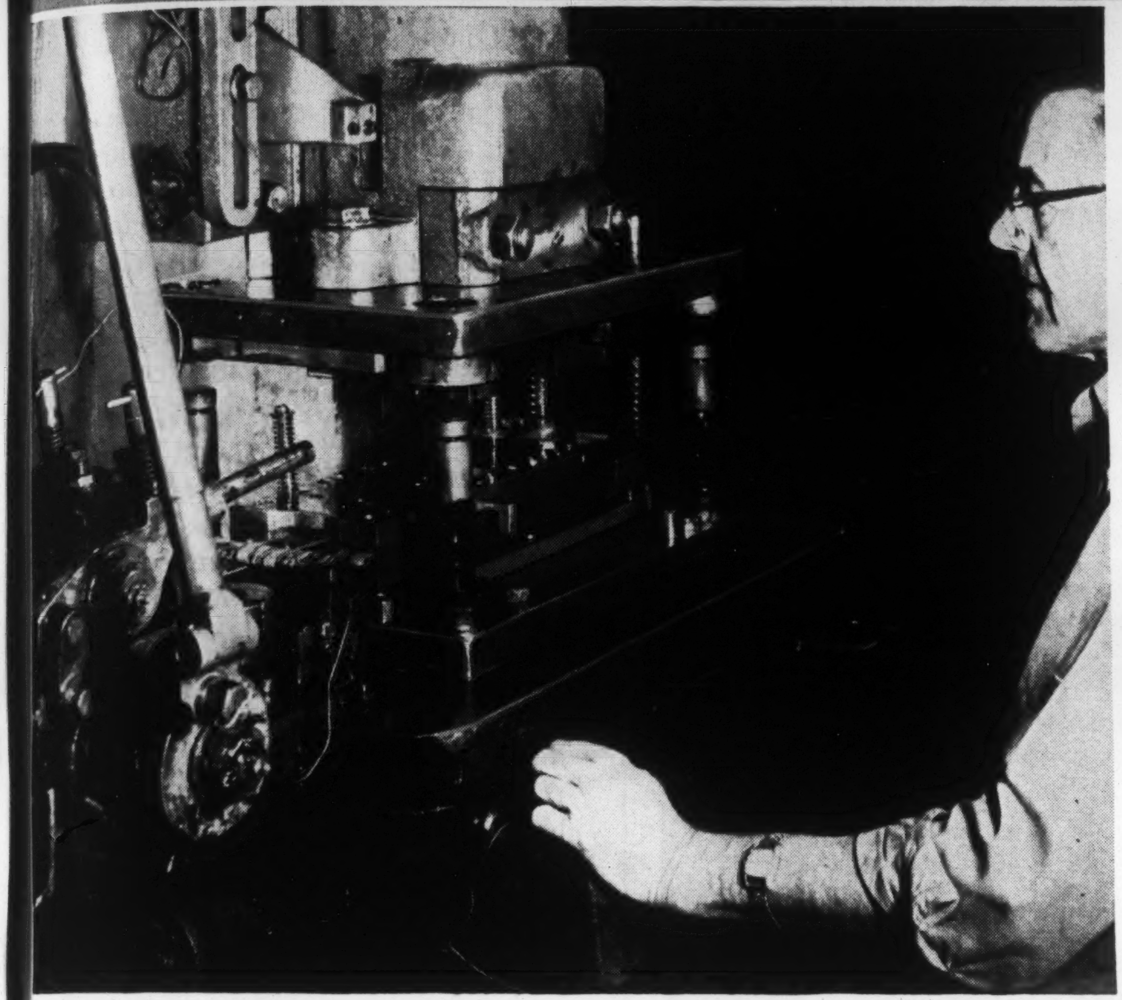

BETHLEHEM TOOL STEEL ENGINEER SAYS:

You Can Salvage Tools Which Have Grinding Cracks

When produced, grinding cracks are usually shallow (0.002 in. to 0.004 in.). If their presence is detected early, it is often possible to salvage the tool, assuming that metal-removal will not render the tool unusable. This can be done by cautious grinding, which removes but a small amount of metal (0.00025 in. per pass), and does not generate excessive heat. To keep heat at the minimum, use a soft, coarse-grit, 36-grain wheel, plus a liberal amount of liquid coolant.

If a number of light cuts are taken, with intervals between cuts to prevent building up temperature, the grinding cracks can be removed, so long as the tool has been properly heat-treated. But if ordinary grinding technique is used, the cracks will enlarge ahead of the grinding wheel, and ultimately will go all the way through the section.

Magnetic-powder testing is required for examination of the tool during the salvage operation, in order to determine when the cracks have been removed. If grinding cracks are detected before a tool is used (this requires magnetic-powder testing in most instances), salvage is usually successful. But should a tool be put in service with undetected grinding cracks, salvage may be impossible because of growth of the cracks in service.

Lehigh H does good job in blanking-and-forming die

Wear-resistance, low distortion, and high compressive strength were the tool-steel requirements needed for a blanking and forming operation at Hickory Springs Manufacturing Co., Hickory, N. C., makers of bed rails and platform rocker hinges. Their choice, and it was a good one, too, was Bethlehem Lehigh H.

The jobs involved blanking and forming cold-rolled strip in thicknesses from 0.060 in. to 0.078 in., in presses of up to 80 tons capacity. The Lehigh H dies, hardened to Rockwell C 58-61, performed satisfactorily, producing about 100,000 pieces between grinds. Only 0.015 in. was removed in redressing.

Bethlehem Lehigh H is an outstanding high-carbon, high-chromium grade of air-hardening tool steel, with the characteristics to take the tough jobs in stride.

TYPICAL ANALYSIS

Carbon 1.55	Molybdenum 0.80
Chromium 11.50	Vanadium 0.40

You'll like Lehigh H the very first day you put it to work. But don't baby it! Give it a real test, one that requires a combination of wear-resistance, shock-resistance, and compressive strength. Your Bethlehem tool-steel distributor has Lehigh H tool steel in stock. Why not call him right now, while you have it in mind.

You Save Time with Hollow-Bar →

If you work with hardened bushings, ring dies or draw rings—in fact, any part requiring a center hole in the steel—you'll save time by using Bethlehem Hollow-Bar Tool Steel. Bethlehem Hollow-Bar is made by a high-speed trepanning process, by which hammer-forged or hot-rolled bars are cored out, then rough-turned on the outside. Hollow-Bar arrives ready to go to work. There's no time lost, no waiting for forged rings or discs. Hollow-Bar is furnished in BTR (Bethlehem Tool Room, oil-hardening), and Lehigh H (high-carbon, high-chrome).

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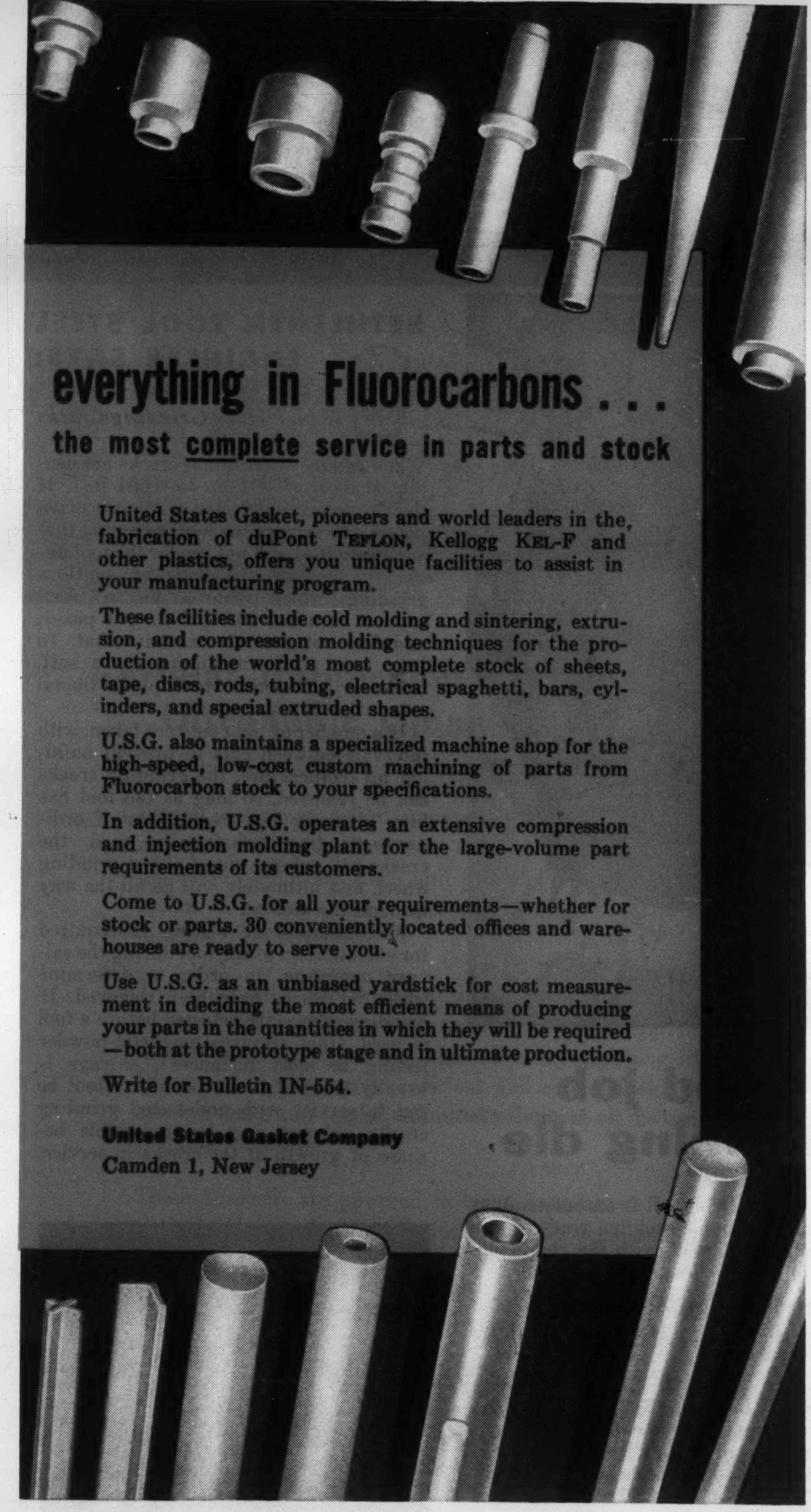

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mets are relatively brittle materials, small surface imperfections can be expected to result in a large loss of strength and impact resistance. The room temperature modulus of rupture and impact strength of titanium carbide-30% nickel-base cermet specimens were given various surface treatments (grinding, lapping, blast cleaning, acid roughening, and oxidizing) and then studied. Results of tests show that:

1. Principal losses in strength occur after the as-ground specimens are given one of the following surface treatments: oxidation at 1600 F for 100 hr, roughening with aqua regia, and severe grinding with silicon carbide abrasive wheel.

2. Modulus of rupture of oxidized specimens increases after refinishing the surface by grit blasting and grinding with a diamond abrasive wheel.

3. Lapping with diamond powder, steel-grit blasting and vapor blasting have little or no effect on the as-ground strength.

Corrosion Resistance of Titanium Alloys

Although there are considerable data available on the corrosion properties of pure titanium, little information exists on the corrosion properties of titanium alloys. Part of the gap has now been filled by Lex B. Folden, Walter L. Acherman and David Schlain. Their study, originally reported in Bureau of Mines Report of Investigations 5299, had three objects: 1) to compare the corrosion resistance properties of titanium consolidated by arc melting and by powder metallurgy techniques, 2) to evaluate the properties of certain alloys of titanium with manganese, chromium, vanadium and iron in typical acid and salt solutions, and 3) since zirconium is extremely resistant to corrosion,

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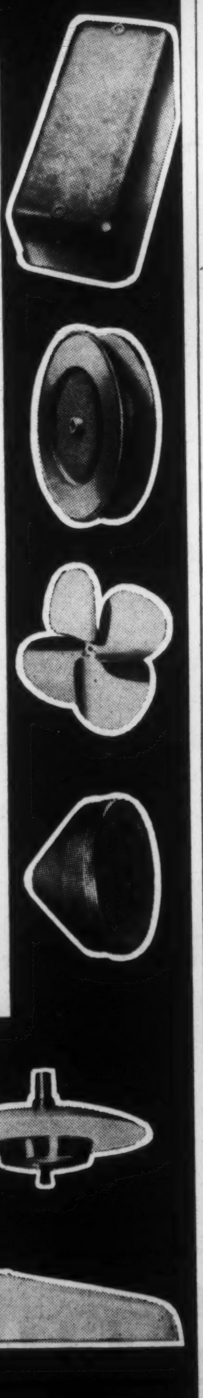

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to determine whether some of the properties of zirconium might be incorporated in such alloys.

Results of their tests indicate that titanium-7% manganese, titanium-1.8 chromium-0.9% iron and titanium-2.7 vanadium-2.7% iron alloys have similar corrosion *properties* in acids and in chloride solutions; however, there are some differences in the corrosion *behavior* of these metals. The titanium-vanadium-iron alloy is a little more resistant than unalloyed titanium in some acid solutions, and the titanium-manganese and titanium-chromium-iron alloys are usually less resistant.

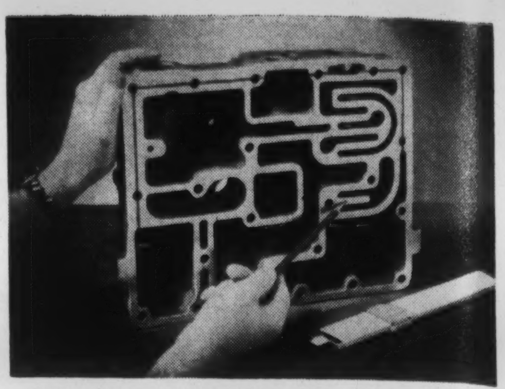
Arc-melted and powder metallurgy titanium possess similar corrosion properties. However, arc-melted titanium is slightly superior to titanium consolidated by powder metallurgy in its resistance to sulfuric and phosphoric acid solutions.

As far as additions of zirconium to titanium are concerned, the investigators found that such additions greatly increase the corrosion resistance of titanium in hydrochloric and sulfuric acid solutions and, to a lesser extent, in phosphoric acid solutions. As little as 14% zirconium is effective, and larger percentages produce progressively better resistance.

Also of interest was the discovery that the titanium-manganese, titanium-chromium-iron and titanium-vanadium-iron alloys become embrittled in the more concentrated acid solutions. The degree of embrittlement is usually proportional to the corrosion rate.

How Grinding Affects Chromium Electroplate

The physical and chemical properties of porous chromium electroplates depend largely on the distribution and depth of oil-retaining "channels." In turn, the



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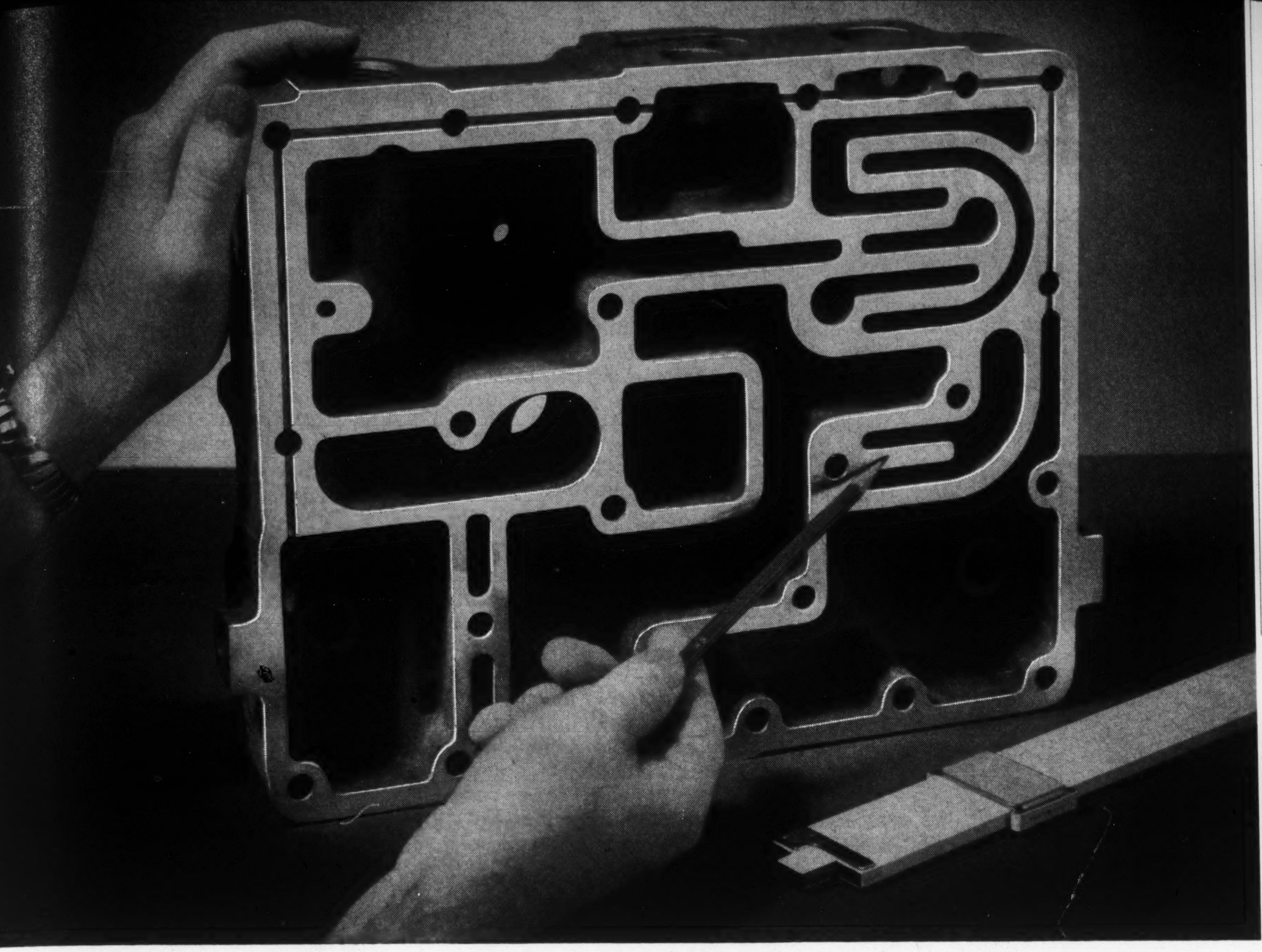


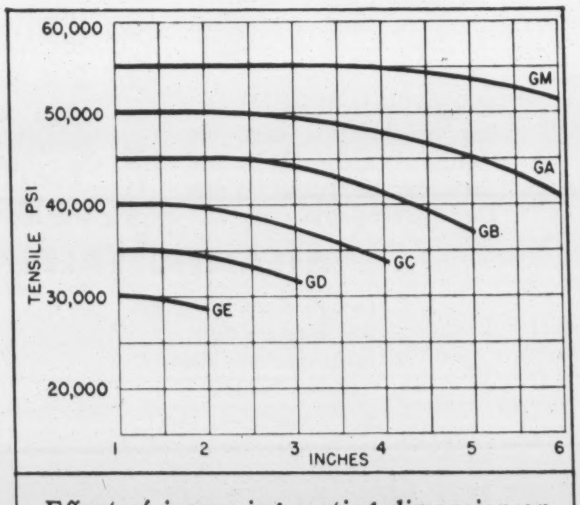
Rigidly controlled Meehanite metal assures uniform physical properties in all sections of complex castings.

This extremely complex Meehanite casting was made in large quantities for use in the production of military tanks. Every casting had to be completely free from defects in order to pass exacting inspection standards and uniformly high physical values were required, despite a number of intricate sections which varied from ¼″ to 2″ in thickness.

Meehanite metal may be poured in both heavy and light sections, minimizing the danger of draws, shrinks, openness of grain and varying physical properties. Containing a controlled quantity of graphite in a pearlitic matrix, Meehanite castings shrink 50% less than steel during solidification, hence eliminating casting strains, warping and cracking.

The uniformity and control of the microstructure of Meehanite castings results in high strength, improved wear resistance, excellent vibration damping, dimensional stability, good machinability and many other engineering advantages.

For more information write today for a free copy of the Meehanite Wheel Chart M-6 which contains complete physical specifications.



Effect of increasing casting dimension on tensile properties of Meehanite castings.

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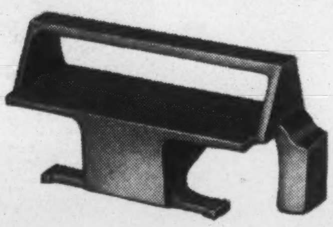
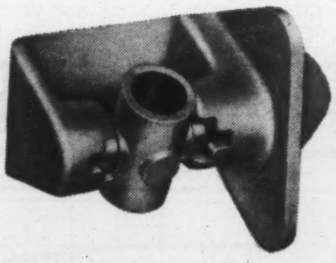
One-piece cast ice cutter for York Corporation's Automatic Ice Maker replaced fabrication of several stainless steel parts.



Cast brush holder for General Electric aircraft generators lowered costs, provided closer tolerances and increased strength.



Rugged skirt door operating mechanism cast for Pennsylvania Railroad cars manufactured by the Budd Company.

Today, ATLANTALLOY CASTINGS are used where precise dimensions and high physical values *plus* economy are essential. These unique precision plaster mold castings can improve *your* product design and reduce *your* costs:

PRECISION — Meet precision machining tolerances. Average limits, ± .005 on one side of parting line. Minimal or no machining or finishing.

DESIGN — Compared with other techniques, this casting process makes possible the production of parts which, because of high physical properties, could not economically be produced by other means. Complicated assemblies requiring several machined parts can be cast accurately as one piece, including designs having internal teeth, stops and blind gear teeth. A wide range of *Atlantalloys* are available for your design needs. Chemical certification on request.

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number or distribution of channels depends largely on plating conditions and their depth and width depends primarily on subsequent anodic treatment. The electroplates are often ground to improve their appearance, but little is known as to how grinding affects the channels in the electroplate. A. A. Mikhaylov, in the Sept '56 issue of the Russian journal *Vestnik Mashinostroveniya,* discusses the results of a number of grinding tests run on porous chromium electroplates.

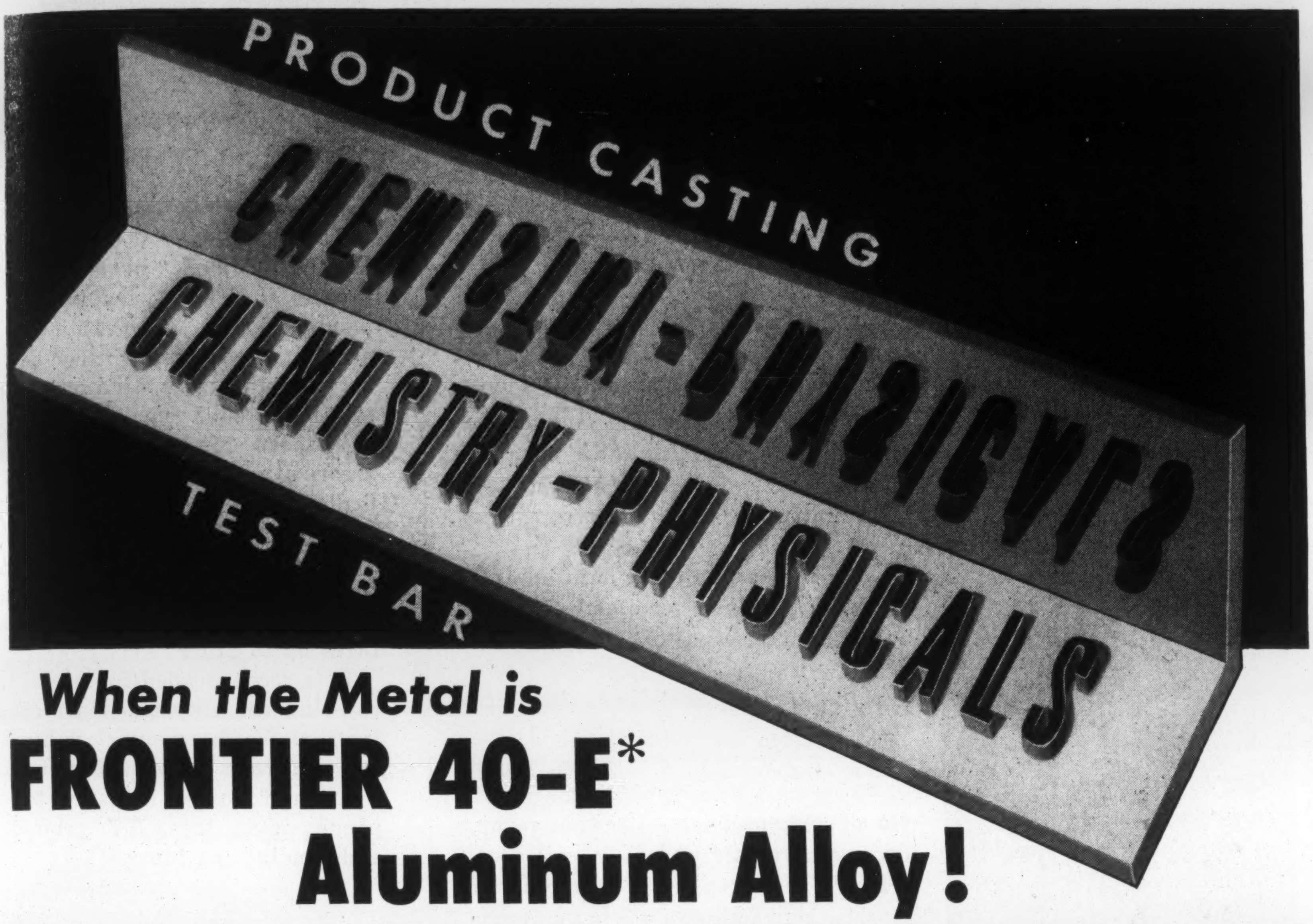
The author finds that the number of channels in chromium electroplates increases with severe grinding and subsequent metal loss. For example, when metal removal is increased from 0.0004 to 0.006 in., the number of channels in the chromium electroplate increases to almost 100 times as many as on unground specimens. Increasing the depth of cut also increases the number of channels. Under the same grinding conditions internal grinding causes less change than external grinding.

Type and hardness of the abrasive wheel used in grinding the electroplate also affects channel formation. For instance, grinding without cooling produces 2½ times as many channels as grinding with cooling. In general, the author concludes that the actual operation of removing metal is much more influential in changing the number of channels than are the thermal effects of grinding.

Vinyl-Metal Laminate Is Abrasion Resistant

A vinyl-metal laminate is being marketed by Arvin Industries, Columbus, Ind. The laminate consists of a vinyl sheeting (ranging in thickness from 0.004 to 0.020 in.) laminated to steel, aluminum and/or magnesium sheets ranging in thickness from 0.015 to 0.060 in. The vinyl sheeting is available

The Test Bar Mirrors the Quality of the Product Casting



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Whether you purchase Frontier 40-E Aluminum Alloy castings direct or from a foundry licensed to produce this alloy, you can be sure that the high qualities that have made this alloy famous are being maintained. How is this controlled? Test bars are required from all licensees. These are sent to the technical research laboratory of the Frontier Bronze Corp. for complete analysis and physical testing.

One of the most unusual features of Frontier 40-E Aluminum Alloy is the fact that the physical properties which spell high quality in the test bar appear uniformly throughout a large casting. And since Frontier 40-E is a non-heat-treated aluminum alloy the high strength physical properties are obtained by natural aging at room temperatures. The high yield strength of Frontier 40-E Aluminum Alloy is of special value in designing parts that must be light in weight and yet resist distortion or deformation.

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Yield Strength	23,500	22,700
Tensile Strength	36,600	35,500
Elongation	7.5	7.5

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Please send me a copy of the Alloy Data Book giving Engineering and Metallurgical Facts on the physical properties of Frontier "40-E".

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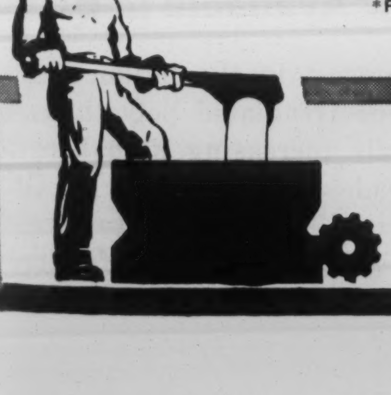

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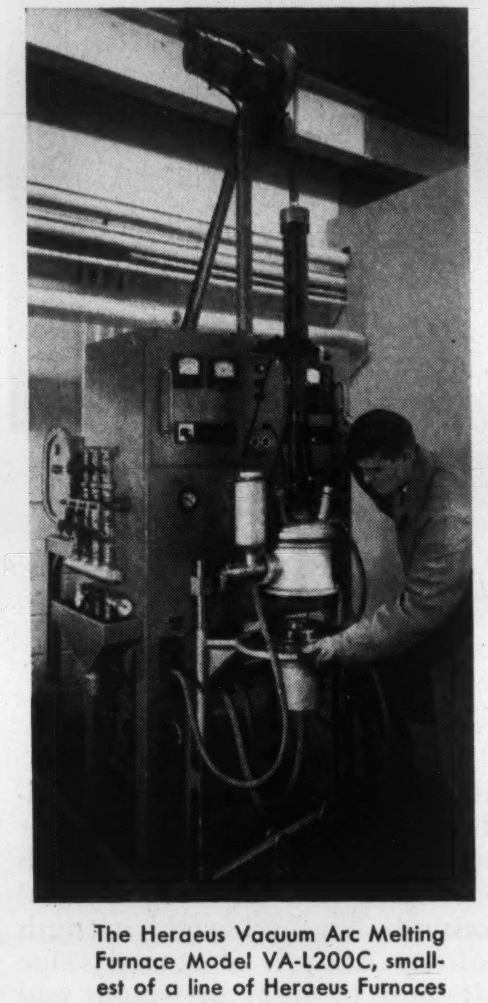


The Heraeus Vacuum Arc Melting Furnace Model VA-L200C, smallest of a line of Heraeus Furnaces sold by CEC.

With this new Heraeus Arc Melting Vacuum Furnace, the VA-L200C, you can get vacuum melts in "buttons" or ingots.

You can get them of Titanium, Zirconium, Tungsten, and other metals or alloys with high melting temperatures. You can get them fast and pure.

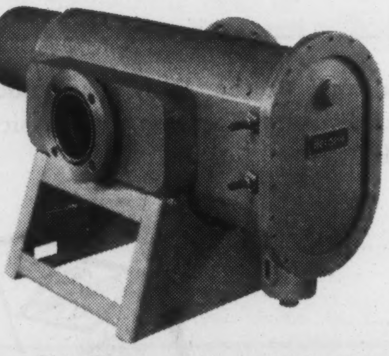
Super-fast mechanical pump—A Roots mechanical vacuum pump pulls pressures in the furnace down to 5×10^{-4}mm Hg—*fast.*

Its throughput of 10,400 micron CFM at 10 microns easily handles sudden gas bursts encountered with certain metals.

No oil contamination—The Roots pump's frictionless rotary pistons require no oil sealing. There can be no contamination from backstreaming vapors in the system.

No crucible contamination—The Heraeus furnace has a water-cooled, copper crucible which cannot contaminate the melt.

Fixed or consumable electrodes—You may use either fixed electrodes of tungsten or metallic carbides, or consumable electrodes of the metal you are melting.



This Roots pump maintains low, vapor-free pressures. A motor operating within the vacuum drives its rotary frictionless pistons.

This Heraeus furnace has many other features valuable in laboratory or small-scale production, including exceptional economy—operating either under vacuum or with an inert gas atmosphere.

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in a number of patterns including wood, leather and marble grains, cloth, basket weave textures and metallized prints.

The plastics-metal material is created through a laminating process that bonds textured and printed vinyl to one or both sides of a flat sheet of metal. The bond between the metal and vinyl is said to be tough enough to permit the sheet to be deep drawn, sheared, crimped, bent, punched, drilled, embossed, stud welded and perforated. The laminate is also said to be resistant to abrasion, corrosion, weather and chemicals, and is heat resistant to temperatures up to 275 F.

It is recommended for use as a covering for air conditioner cabinets, clothes hampers, clock housings, game boards, furniture, lighting fixtures, luggage, telephone cases, toys, TV cabinets and vending machines.

New Plastics Material Developed in Italy

A new plastics material, made by polymerizing propylene, is said to be lighter than nylon and stronger than steel when used in certain applications. Developed by Montecatini Chemical Co., Ferrara, Italy, the material is said to be so light that it will float on water. Full scale production of the new material called Moplen, is expected to get underway early this summer.

Irradiated Polyethylene Now Available in Britain

Interest in the production and use of irradiated polyethylene is rapidly increasing both here and abroad. Recently, W. R. Grace acquired the rights to Sequoia Process' Hyrad process for irradiating polyethylene (see M&M, Jan

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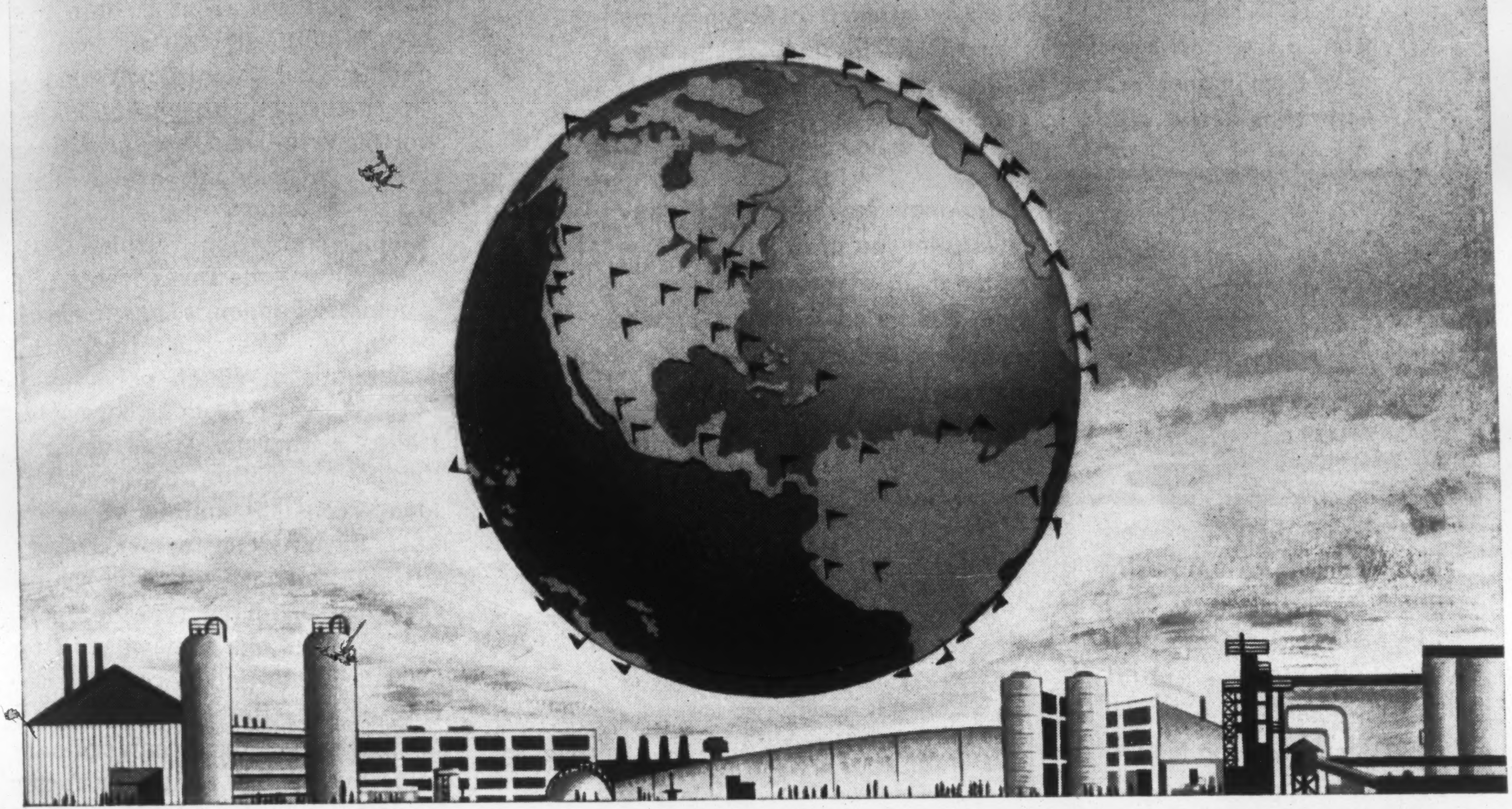

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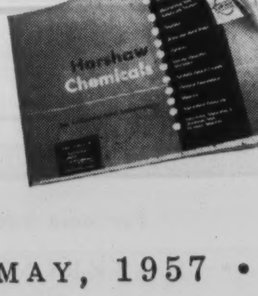

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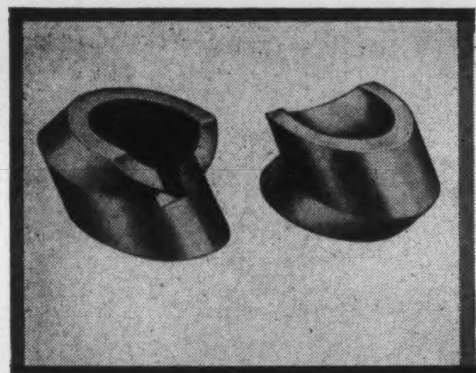
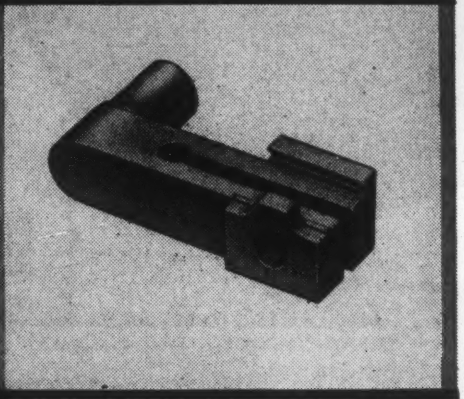
Basic Considerations in Selecting alloys . . . . . . for your INVESTMENT CASTINGS

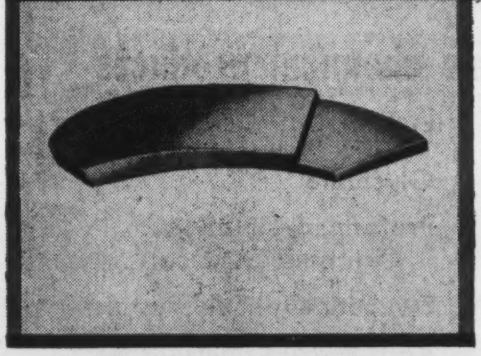
DO YOU KNOW THAT . . . an investment casting produced from a low cost metal may be MORE EXPENSIVE than one cast from higher priced material that may also have characteristics better suited to your requirements.



These angle connectors were originally investment cast in mild steel, a low cost material. To overcome corrosion problems, 303 stainless was substituted and because of its better castibility there was no increase in cost. Now, silicon brass is being used at a 10% saving on the original selling price.



This gage mount is an excellent example of unusually good casting characteristics of one metal offsetting a decidedly higher material cost. Originally priced in SAE 8620 steel, it was changed to beryllium copper at a 15% saving in unit price.



This simple textile machine part requires a high degree of wear resistance. Casting in the right metal provided better properties at lower cost than when machined from tool steel.

Get more complete information for this is only a small part of the story telling how the right metal selection for investment castings can often increase efficiency and reduce costs. WRITE today for Bulletin 116-205 . . . it's FREE!

SEE US IN BOOTH 1333 DESIGN ENGINEERING SHOW

HITCHINER
Manufacturing Company
MILFORD 7, NEW HAMPSHIRE
REPRESENTATIVES IN PRINCIPAL CITIES

For more information, turn to Reader Service Card, Circle No. 373

'57, p 153) and General Electric announced that it was increasing production of irradiated polyethylene from 300,000 to 1.6 million lb a year (see M&M, Mar '57, p. 167). Reports from Britain indicate that the British are also producing irradiated polyethylene. Up to the present, production has not gone beyond the pilot plant stage, but samples are available for testing purposes.

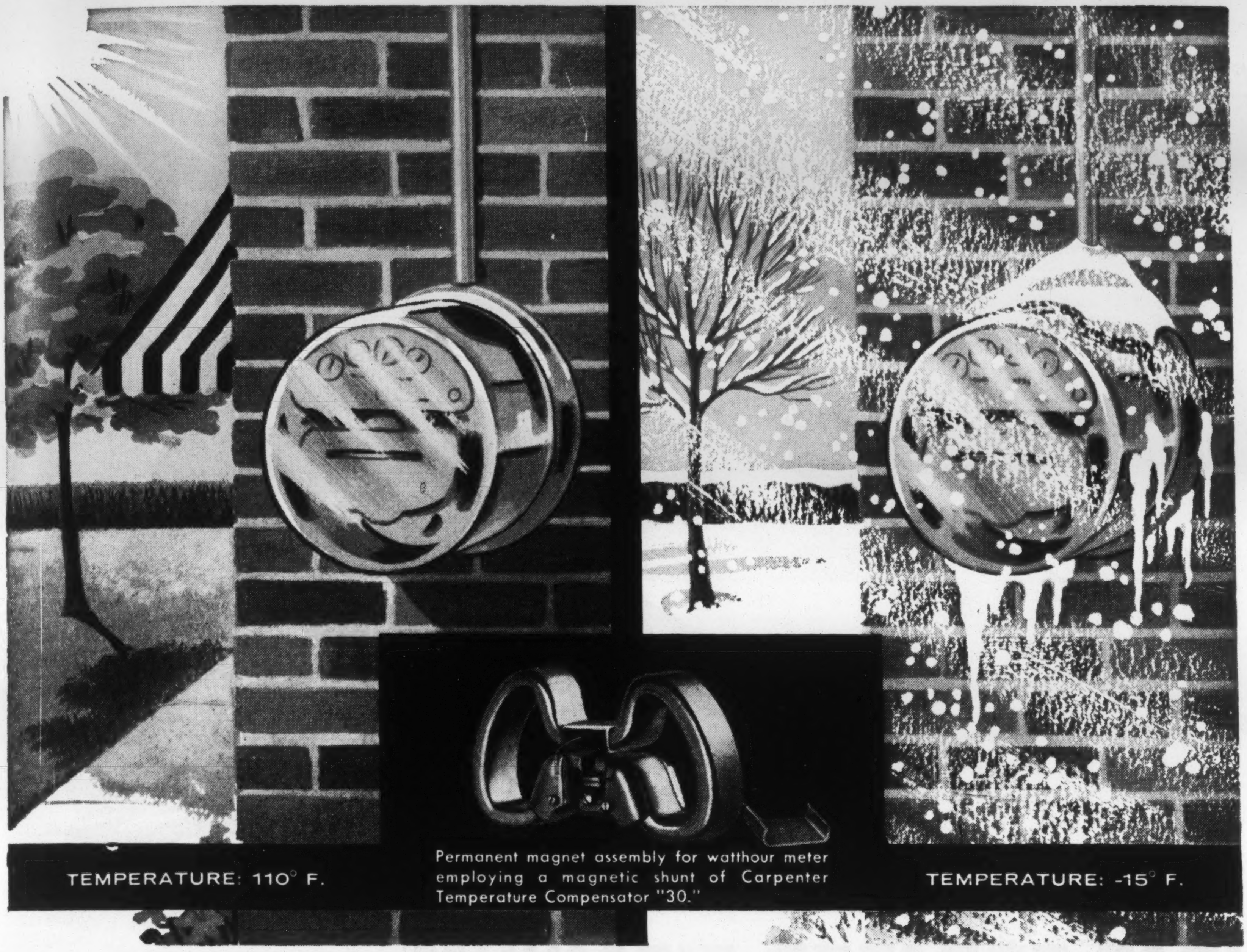
The irradiation technique, developed by Tube Investments Ltd., Adelphia, London, seems to closely resemble American irradiating techniques in which polyethylene is transformed from a thermoplastic to a thermosetting material. Present production at Tube Investments consists mainly of irradiated polyethylene tape.

Chemically, the tape is said to resemble ordinary types of polyethylene but has somewhat better solvent, acid and oil resistance. Electrically, the tape has better breakdown strength than ordinary polyethylene but its power factor is slightly decreased. Mechanical properties are said to be slightly improved and heat sealing is possible, though the bond is somewhat weaker than with ordinary polyethylene.

According to the company, the irradiated tape has already been tested and found effective for food, drug and pharmaceutical packaging; drum liners; protective pipe wraps and shrinkable packaging film; protective and encapsulating material for irregular objects as a moisture barrier for wire and cable; as a ground insulation for motor and generator coils; and as an insulation for power and communication cables.

Fluorocarbon Plastics
Coming in June
A 20-page article that summarizes and compares the properties of available commercial types.

Carpenter **. . . pioneering in improved Tool, Alloy and Stainless Steels through continuing research**



TEMPERATURE: 110° F.

Permanent magnet assembly for watthour meter employing a magnetic shunt of Carpenter Temperature Compensator "30."

TEMPERATURE: -15° F.

When Precision Equipment Must Behave at Varying Temperatures . . .

Take Advantage of *Carpenter* High Nickel Alloys !

A specially-engineered steel in Carpenter's complete line of high nickel alloys is guarding the accuracy of watthour meter performance in all kinds of weather. Its use covers a wide range of electrical equipment such as watthour meters, voltage regulators, speedometers and aircraft tachometers.

This alloy, Carpenter Temperature Compensator "30", is produced by specialists under strict quality controls. It is another example of how Carpenter's pioneering role in producing *specialty* steels to meet *special* applications works for you in your effort to build better products at a reasonable cost.

And Temperature Compensator "30" is but one of many Carpenter specialties. Other "extremely sensitive" alloys in this line respond to very weak electrical currents . . . permitting you to design smaller, lighter weight units. Still another Carpenter High Nickel Alloy assures precision product performance with practically no size change through temperature ranges up to 400°F.

Take this step for product improvement, now: Write on your company letterhead for detailed information on Carpenter Temperature Compensator, Low Expansion, High Permeability and Glass Sealing Alloys in such forms as strip, wire, bars, tubing and forging billets.

***Carpenter* STEEL**

high nickel alloys

The Carpenter Steel Co., 135 W. Bern St., Reading, Pa. Export Department: The Carpenter Steel Co., Port Washington, N. Y. "CARSTEELCO"

For more information, turn to Reader Service Card, Circle No. 392

Progress with TITANIUM

HEAT TREATED TITANIUM

...helps the Hustler spread its wings

The Plane: The U.S. Air Force's delta-winged B-58 Hustler, made by Convair—Fort Worth. To achieve supersonic speeds, designers had to make optimum use of all materials, considering strength, weight, high temperature performance.

The Improvement: 6Al-4V titanium alloy, furnished by Mallory-Sharon, was used in certain applications as a direct substitution for steel for wing fittings bearing heavy loads. This alloy, weighing 44% less than steel, has equal or superior strength for the heat-treated conditions.

The Service Need: The Hustler is the first major application of a new technique that extends titanium usefulness—heat treating. The alloy material is supplied in a medium strength level which permits ease of rough machining. Then the part is heat treated and finished machined to the high strengths desired in service.

To help in this development, Mallory-Sharon service engineers recommended and assisted Convair in establishing qualified subcontractor sources. We furnished bar stock to these companies for evaluation, recommended furnace type, conditions, temperatures, and heating times. We performed mechanical and chemical tests before and after heat treatment, to guide this phase of the program to a successful conclusion.

The Result: Improved performance; America's first supersonic bomber. Use Mallory-Sharon's outstanding technical service on *your* applications of this new metal. For information, write Dept. G-5.

MALLORY Ti SHARON

MALLORY-SHARON TITANIUM CORPORATION • NILES, OHIO

Producers of titanium and titanium alloy sheet, strip, plate, rod, bar, billets

For more information, turn to Reader Service Card, Circle No. 627

PRICES AND SUPPLY

The Outlook

by **Herman B. Director,** *Consultant, Washington, D. C.*

Steel consumption to decrease in '57

The continued demand for heavy steels will probably sustain production at about 90% of capacity for the rest of 1957. However, consumption of other steel products should decrease in the second and third quarters. There are at least two factors responsible for this: first, in spite of the fact that automobile production was higher in the first quarter of 1957 than it was in the first quarter of 1956, sales this year are well behind last year. In addition, sales of appliances are low and there has been a serious drop in residential housing construction.

Secondly, because of new labor contracts additional sizable increases in the price of steel are expected shortly. As a result, use of steel in end items such as automobiles and major appliances should decrease even further.

Copper still plentiful

Major copper producers have recently cut mine production substantially and additional cuts are expected shortly. One reason for this is that consumers' inventories are greater than was previously estimated, and with the summer seasonal downturn in prospect, it seems unlikely that consumers will be rushing back into the market.

The price of copper has now reached a point where the Government, under its guaranteed market price contract arrangements with copper producers, will have to begin buying copper in large tonnages at 31¢ per lb. Barring work stoppages in Chile or other foreign areas, pressures will continue for a further reduction in price below the 32¢ per lb level recently established by copper producers.

Aluminum use up, supply sufficient

Although consumption of aluminum die castings continues to be high, especially in the automotive industry, the loss of about 25,000 tons of primary aluminum production because of power shortages in the Pacific Northeast had apparently little or no effect on availability.

Continued expansion by the aluminum industry, however, will tend to sharpen competition not only between aluminum and other materials, but between competing producers. Nevertheless, in spite of price cuts on some fabricated products, there seems to be little inclination on the part of producers to cut prices on primary ingot.

More magnesium is being used for die casting

Demand for magnesium and copper for die casting applications is increasing. According to reliable reports, actual demand for magnesium for die casting exceeds published consumption information. Here again competition among zinc, aluminum, magnesium and copper will be much sharper as supplies are increased.

Cobalt supply up, consumption down

Although cobalt production is at the highest level in history, consumption is at a minimum. Under the stimulus of Government subsidy programs, cobalt supplies have been and are pouring into the United States for Government account. This, plus the fact that new domestic sources will probably be sufficient to satisfy over two-thirds of domestic demand, may well point to a decrease in the price of foreign cobalt.

Selenium prices may be cut

There is a good possibility that selenium prices will be reduced. Several factors are responsible: for one thing, both sales of TV sets and the use of selenium rectifiers in them have been reduced considerably. For another, the switch from selenium to silicon and titanium came at the same time producers switched from commercial grade selenium to high purity grade. As a result, there is more selenium available than is required. To further complicate the situation, export demands seem to have disappeared.

Argon supplies to defense

Argon, an inert gas used in the production of titanium ingot, stainless steel and other defense materials, will be the first chemical (since the Korean War) to be controlled by the Government production and distribution control order.

The shortage of argon, which has already held up production of important metals for defense, has resulted from work stoppages at two of the nation's largest producing facilities. The controlling order, issued by the Business and Defense Services Administration, Dept. of Commerce, places a ceiling of 85% of scheduled production on required acceptance of defense rated orders by argon producers.

Lead prices to remain unchanged

Lead prices, maintained at current levels as a result of the U. S. Government's subsidy purchase program, will probably not change for at least six months. The U. S. Government's barter program will undoubtedly soak up world supplies in order to stabilize world prices. Consumers of batteries, pigment, gasoline and covered cable will bear the cost.

The Government is also apparently willing to buy as much lead as domestic producers have to offer in excess of demand. In effect, therefore, the U. S. Government will stabilize world lead prices through barter and domestic purchase.

More nickel for consumers

Consumers should benefit from arrangements recently completed by the U. S. Government which overcome difficulties previously encountered in the attempt to divert nickel to industry from Government account. The secondary market for both high nickel containing scrap as well as stainless steel scrap is already feeling the effects of this program. Although still insufficient to meet all industry demands, nickel supply will be substantially increased. Recent announcement of new production by the Freeport Sulphur Co., beginning sometime in 1959, makes continued diversion of Government stocks a virtual certainty.

Plywood competition

Two important groups are currently engaged in a heated battle over plywood imports. The Hardwood-Plywood Manufacturers Committee is sponsoring a high-powered campaign to curtail imports of Japanese plywood. As a countermeasure, the Imported Hardwood-Plywood Assn. is taking steps to forestall import restrictions. The Tariff Commission has recommended against a tariff increase.

An innocent though interested bystander who stands to lose by competition from imports is the plastics manufacturer. The plywood industry consumes large quantities of phenolic-urea and resorcinol adhesives.

World tin cartel moves for higher prices

The Tin Producers Assn. has raised the price at which the Tin Buffer Stock Agency will purchase tin from 80¢ to 97½¢ per lb, making it mandatory for the producers buying agency to buy tin at prices much higher than originally intended in the event demand lags behind supply. The likelihood of tin dropping below 97½¢ per lb on world markets is, therefore, much reduced. Consumers in the United States, by far the largest of the world's consumers, have expressed great concern over this action. We expect that research on substitute packaging materials will be pushed with much more energy.

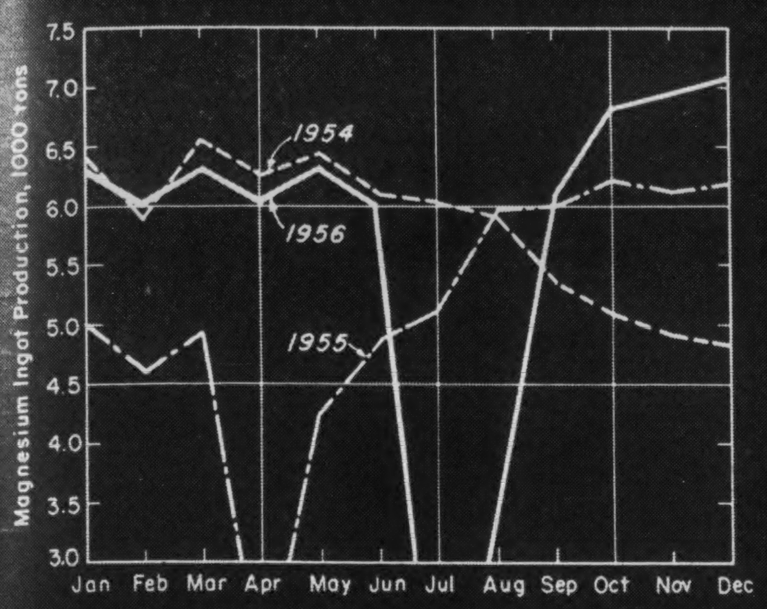
Back door budget

Congress has removed virtually all funds for the strategic materials stockpiling program from the Federal Budget. This appears to be a move aimed at saving the Government some $130 million for the procurement of industrial materials. In making the cut, the House Committee indicated that with over $8 billion of materials already on hand, or on order, further funds are unnecessary.

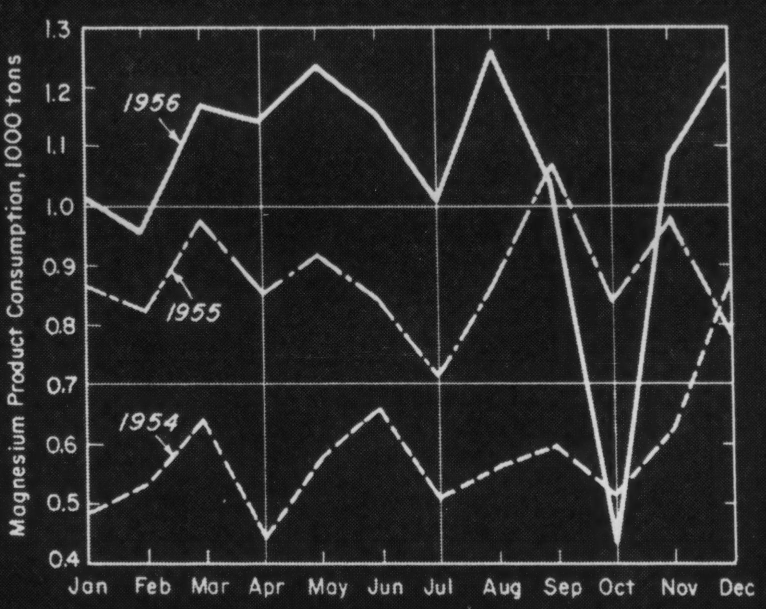
In fact, this cut does not represent real savings because the materials in question have for the most part already been purchased with money borrowed under the Defense Production Act.

The Defense Production Act of 1950 established the "Borrowing Authority" which, in addition to providing loans for exploration, provides for commitments by the Government to purchase materials for Government use or resale. Under this law, the General Services Administration and other agencies borrow money from the Treasury to buy materials. Authorization to borrow amounts to about $9 billion. Gross transactions already consummated amount to $7.6 billion, of which over $5 billion are for materials purchased for Government use or resale.

In view of the curtailed demand for industrial materials, prospects for resale of this material to industry are virtually nil. The only prospect for resale is to the Government's strategic stockpile. Cutting these funds out of the Budget, therefore, does not save any money but, in fact, results in additional expenditures required to pay the interest on money which was borrowed in order to buy these same materials under the Defense Production Act.



Ingot production *compared over the last three years.*



Wrought product consumption *compared over the last three years.*

Magnesium Production Up in '56, Higher in '57

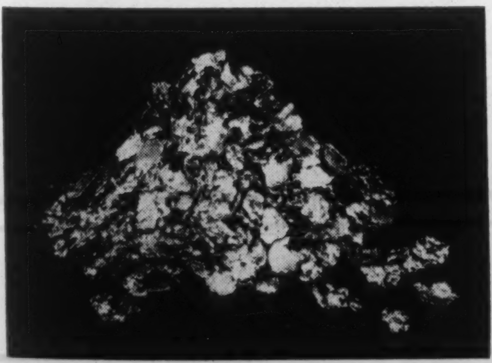
■ Despite serious curtailments last summer, production of magnesium reached a new peacetime high in 1956 (see accompanying graphs). The Magnesium Assn. says ingot production increased by 12% over 1955 and shipments of wrought products gained by 20%. And although total ingot production in 1956 was slightly lower than production in 1954—68,347 tons compared to 69,729 tons—indications are that 1957 will see the largest increase yet. In fact, the magnesium industry has set itself the goal of producing 80,000 tons, or 17% more than in 1956.

As a result of new facilities added by Dow Chemical Co. and others, ingot production and wrought product shipments in Dec were up from Nov by 4% and 15%, respectively. According to the Magnesium Assn., "there is no reason to believe that the present steady growth will not continue this year."

The rise in production and consumption of magnesium is considered to be directly attributable to the increasing demand for light metals for military as well as civilian applications (for a general survey of new uses of magnesium see M&M, Jan '57, p 112).

More Zirconium Available at Lower Prices

■ To meet increased industrial demands for zirconium, U. S. Industrial Chemicals Co. has boosted the zirconium-producing capacity of its new plant from 1,500,000 to 2,000,000 lb per year.



Zirconium platelets *are claimed to be superior to sponge, yet cost less.*

Scheduled to go on stream during the second quarter of this year, the new plant will produce reactor grade and commercial grade zirconium in the form of platelets — irregular flakelike pieces about the size of dimes and quarters. According to William C. Greenleaf, manager of metals development, platelets are superior to ordinary sponge in that 1) they are nonpyrophoric, and nonhygroscopic and extremely pure; 2) they can be compacted for melting as easily as sponge, but with virtually no waste; and 3) the restrictions normally imposed on shipping of zirconium sponge do not apply to the platelets.

Prices for hafnium-free zirconium range from $4.75 to $6.50 per lb, depending upon quantity, as compared with the present price of about $12 per lb for sponge. The lower price, according to U.S.I., is practical as a result of its sodium process—the first semicontinuous process for making zirconium — which requires a lower initial investment than the conventional Kroll process. Commercial zirconium, which is not hafnium-free, will sell for about $1.50 less per lb.

(Prices on p 286; more news p 292)

Prices of Materials

Changes since last month are bold faced

NONMETALLICS

Prices for large quantities for range of grades, color, sizes; given in $/lb

RUBBER

Material	Dry	Latex
Butadiene-Acrylonitrile	.49-.65	.44-.54
Butadiene-Styrene	**.17-.30**	.26-.32
Butyl	.23-.28	—
Neoprene[a]	.39-.75	.37-.47
Silicone[a]	1.90-4	—
Polysulfide[a]	.47-1	.70-.92
Natural	.33[b]	—

[a] Less than carload quantities.
[b] Average spot price for month of Jan.

GLASS FOR REINFORCED PLASTICS

Fabric ($/yd, 38 in. wide)[a]	
112 Woven	.48
181 Long-shaft satin weave	1.03
143 Unidirectional	1.00
Roving[a]	
Continuous	.40
Continuous spun strand	.36
Continuous chopped spun	.38
Milled fibers (1/32-¼ in.)[a]	.45
Mat	
Chopped strand (2 in.)[a,b]	.52-.72
Surfacing ($/1000 sq ft)[c]	10-19
Continuous chopped strand (¼-2 in.)	.40

[a] Price includes binder or finish.
[b] Price varies with binder.
[c] 0.010-0.020 in. thick.

THERMOSETTING PLASTICS

Material	Molding Compounds	Laminating, Casting Resins
Alkyd	.34-.53	—
Epoxy	—	.45-.80
Melamine	.42-.45	.40-.41
Phenolic	.20-.40	.17-.34
Polyester	.42	.32-.50
Silicone	2.75-5.40	1.55-1.74[a]
Urea	.19-.33	—

[a] 60% solids content.

All prices are approximate and given solely for general guidance of those responsible for materials selection.

THERMOPLASTICS

Material	Molding Compounds	Sheet (.030-.250 in.)	Rod		Tube	
			⅛-¼ in.	⅜-1¼ in.	⅛-¼ in.	⅜-1¼ in.
Acrylic	.51-.59	.49-2.15	.90-1.15	.80-.90	1-1.15	.90-1
Cellulosic						
Acetate	.36-.65	.92-1.16	.75-1	.65-.75	.85-1	.75-.85
Butyrate	.50-.72	1-1.28	.95-1.20	.85-.95	1.05-1.20	.85-1.05
Nitrate	—	1.60-2.73	1.45-1.75		2.25-5.00	
Propionate	.51-.63	—	—		—	
Fluorocarbon						
PTFCE	7-8	15-23	18-22	14-20	20-22.50	16-20
PTFE	4.50-7.45	14.30-11	13		13	
Nylon	1.35-2.30	—	3		3	
Polyethylene	.37-.56	.85-1	.75-1	.65-.75	.85-1	.75-.85
Polystyrene	.27-.44	.57-.61	.65-.90	.55-.65	.75-.90	.65-.75
Vinyl	.27-.43	.62-.92	.75-1	.65-.75	.85-1	.75-.85

NONFERROUS METALS

Mill base prices for large quantities; given in $/lb except where indicated

ALUMINUM

Pig (99-99.9%)	.25-.27
Ingot (99-99.9%)	.27-.29
Foil (5-0.5 mil)	.55-.77
Alloy Ingot (13, 43, A132, 214)	.29-.32
Sheet (1100, 3003; 3-.03 in.)[a]	.40-.45
Plate (1100, 3003, 5050, 3004, 5052)[a]	.40-.43

[a] Mill finish.

BRASS

Form	Cart., 70%	Low, 80%	Red, 85%
Sheet, Strip	.48	.50	.51
Seamless Tubing	.50	.53	.54
Rod (not f.c.)	.47	.50	.51
Wire	.48	.51	.52

COPPER

Ingot (elec)	.32
Sheet, Strip (hot rolled)	.54
Seamless Tubing	.54
Rod, Drawn	.51
Rod, Free Cutting	.60
Wire	
Round	.37
Square, Rectangular	.41
Magnet	.45

LEAD

Common Grade	.16

MAGNESIUM

Pig (98.8%)	.36
Ingot (98.8%)	.37
AZ91B Ingot (die casting)	.37
AZ91C Ingot (sand casting)	.41[a]

[a] Delivered price.

NICKEL

Form	"F"	"A"	Monel
Ingot	.75[a]	—	—
Rod	—	1.07	.89
Sheet, C.R.	—	1.26	1.06
Strip, C.R.	—	1.24	1.08
Seamless Tube	—	1.57	1.29

[a] Delivered price.

TIN

Primary[a]	.98

[a] Delivered price.

(continued on p 288)

Need Tubing? Then . . .

LOOK NO FURTHER FOR QUALITY

Because *BISHOP* small diameter tubing is not excelled in accuracy of I.D. and O.D. . . . in dimensional precision . . . in tolerances . . . in finish.

Whether it be for a precision part in an instrument . . . a heat exchanger in today's high speed aircraft . . . a thermocouple . . . an electronic or atomic application.

Wherever tubing is needed to meet corrosion, heat, shock, stress, psi pressure resistance and vibration . . . for highest quality and performance *specify* BISHOP tubing, at comparable prices.

SEAMLESS AND WELDED AND DRAWN STAINLESS STEEL TUBING

Mechanical, Capillary, Hypodermic and Aircraft Grade

(.008" to 1.000" O.D.—.003" to .083" Wall)

NICKEL AND ALLOY TUBING

(up to .625" O.D.)

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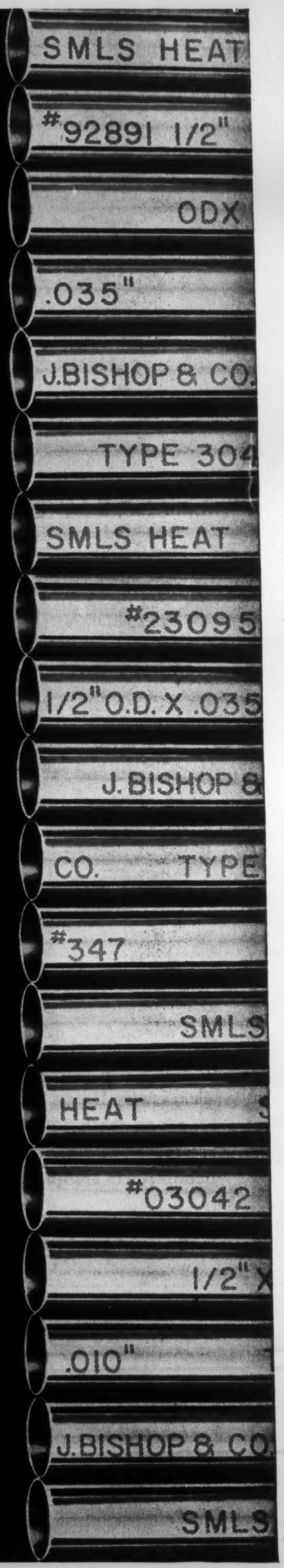
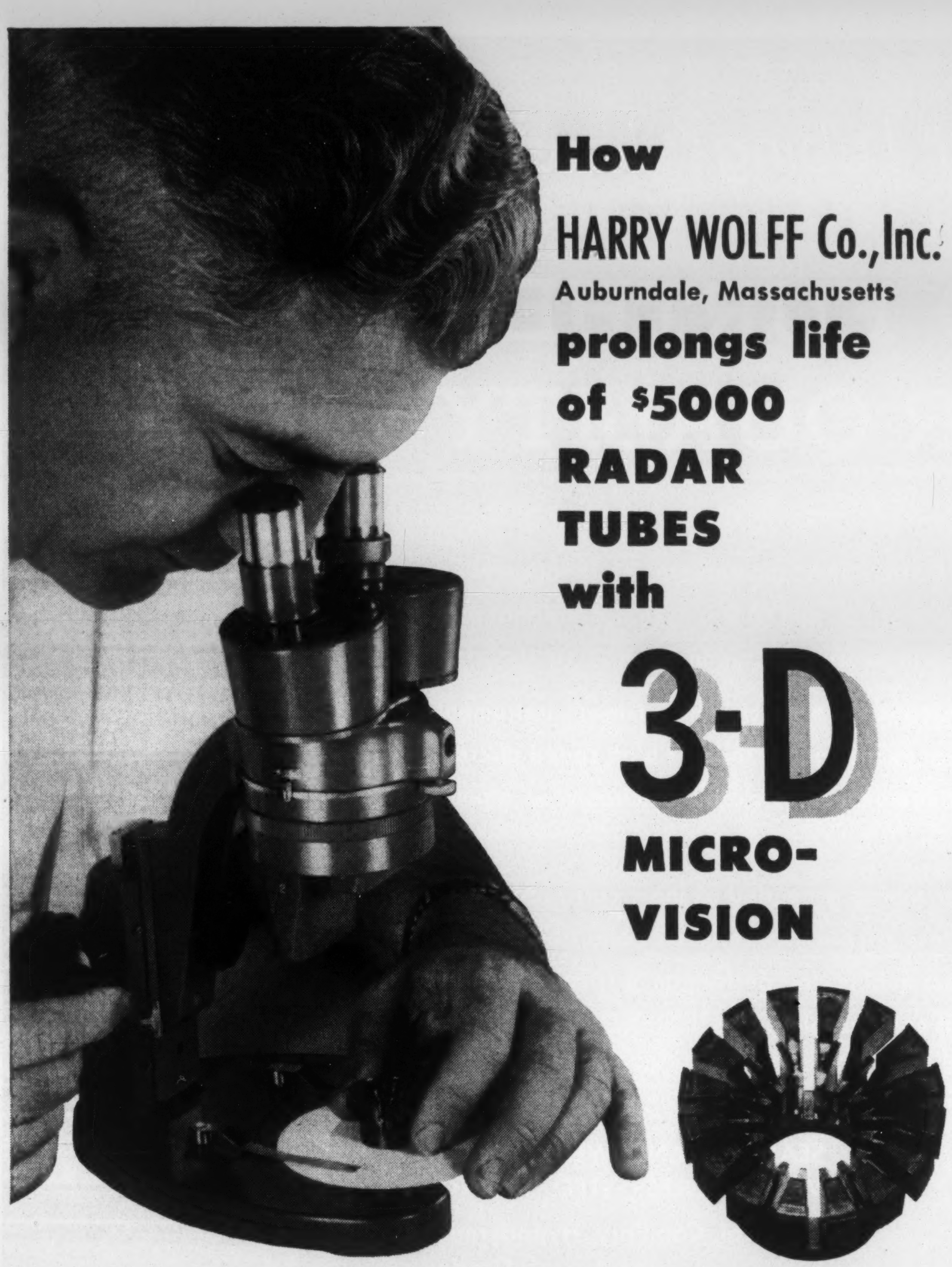

SMLS HEAT
#92891 1/2"
ODX
.035"
J.BISHOP & CO.
TYPE 304
SMLS HEAT
#23095
1/2" O.D. X .035
J. BISHOP &
CO. TYPE
#347
SMLS
HEAT
#03042
1/2" X
.010"
J.BISHOP & CO.
SMLS



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prolongs life of $5000 RADAR TUBES with

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A tiny burr on this tuning crown will burn off at normal operating temperatures and cause radar tube failure. Precision components like this are made of metals that cost over $100 per pound. The tube costs up to $5000. Obviously, rejects and failures are prohibitively costly.

That's why Harry Wolff Co., Inc., uses Bausch & Lomb Stereomicroscopes to check 368 different edges of each tuning crown. Inspectors see the work right-side-up, clearly magnified in vivid 3-dimensional detail. Burrs are quickly revealed, and easily scraped off.

And that's why Harry Wolff, president, says: "We consider the B&L Wide Field Stereomicroscope as important to us as a precision lathe."

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PRICES AND SUPPLY

TITANIUM

Sponge (99.3+%)	2.50-2.75
Bars, Rod	7.10-7.35
Plate	9.25-11.25
Sheet, Strip	11.40-12.10
Wire	8.50-9.00

ZINC

Primary[a]	.13-.14[c]
Die Casting Alloys[b]	.18-.19[c]
Sheet	.24
Ribbon	.22

[a]Prime Western—Special High Grade.
[b]Alloys 2, 3, 5. [c]Delivered price.

METAL POWDERS

Aluminum [a,b]	.36
Brass[a]	.37-.47
Copper (elec or red.)[a]	.46
Columbium	120
Molybdenum (98%)	3.80-4.10
Tantalum	49
Tungsten (C-red. 98.8%; H_2-red. 99+%)	4-5[c]
Zirconium	
Flash Grade	11.50
Electronics Grade	15

[a]Price for —100 mesh. [c]Delivered price.
[b]Freight allowed.

OTHER NONFERROUS METALS

Cadmium (bars)	1.70
Gold	$35/troy oz
Indium (99.97+%)	$2.25/troy oz
Manganese (99.9%)	.33[a]
Palladium	$23-24/troy oz
Platinum	$92-95/troy oz
Silver	91¢/troy oz
Tantalum (sheet, rod)	55-60
Vanadium	3.45
Zirconium (sheet, strip, bar)	27-35

[a]Delivered price.

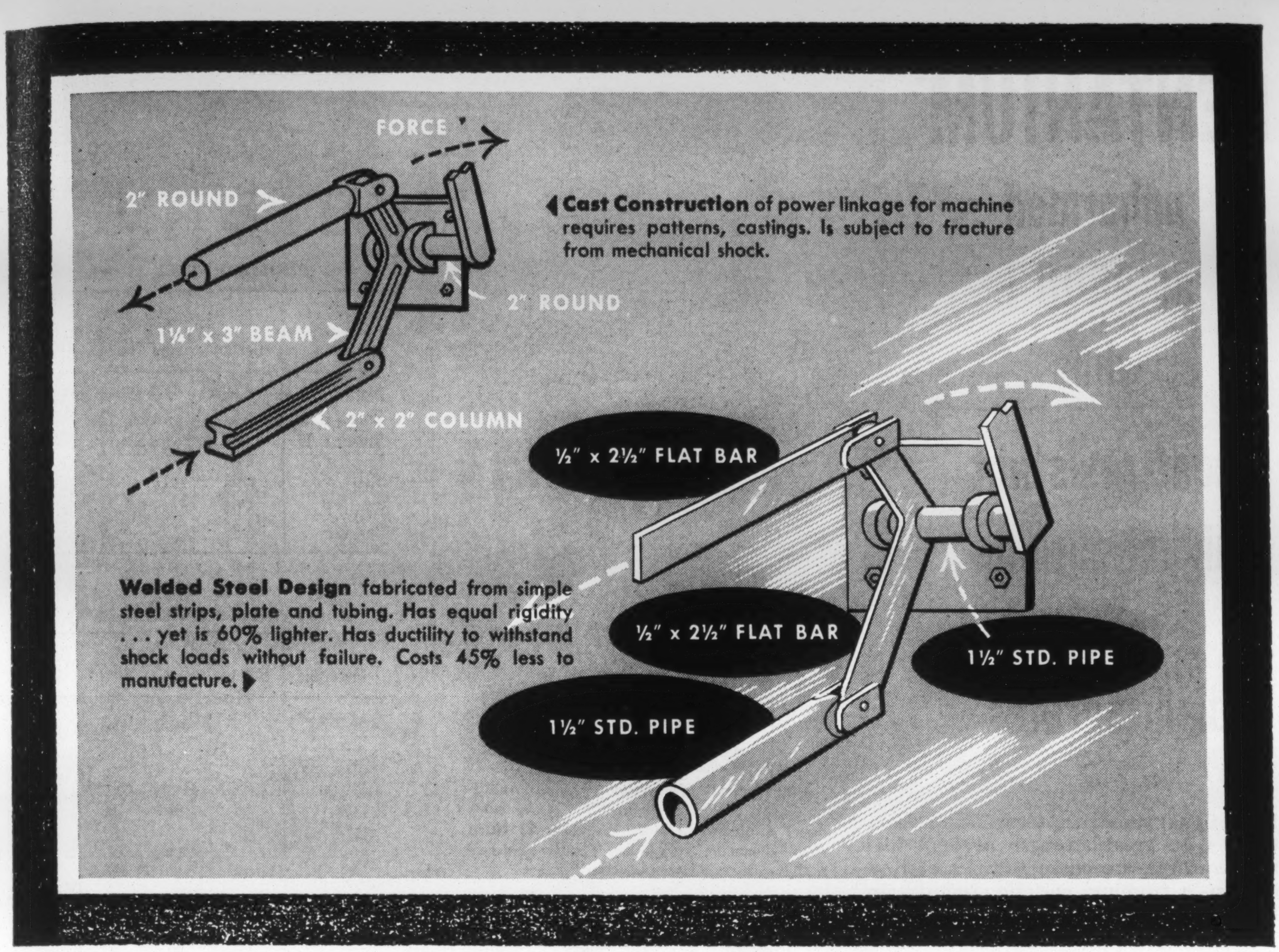
IRONS AND STEELS

Mill base prices for large quantities

SEMIFINISHED STEEL ($/net ton)

Ingots, Alloy	74
Billets, Blooms, Slabs	
Carbon, Re-rolling	74
Carbon, Forging	92
Alloy, Forging	107
Seamless Tube Rounds	112
Wire Rods	$5.85/cwt

(continued on p 290)



Cast Construction of power linkage for machine requires patterns, castings. Is subject to fracture from mechanical shock.

Welded Steel Design fabricated from simple steel strips, plate and tubing. Has equal rigidity . . . yet is 60% lighter. Has ductility to withstand shock loads without failure. Costs 45% less to manufacture.

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and cut costs 45% . . . use 60% less material

MACHINE DESIGNERS

Write for Weldesign Sheets giving latest ideas in saving material and cost with welded steel.

THE machine linkage shown illustrates how costs can be cut on many types of product designs. Production savings come from lower material costs and from faster, simpler fabrication. The product is also stronger, more dependable in service since weight and inertia forces are lower. Modifications in design to suit customers' special needs are simpler too, because patterns and castings are no longer required.

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The World's Largest Manufacturer of Arc Welding Equipment

When steel is 3 times stronger than iron

Has two and one-half times the rigidity

Yet costs a third as much per pound

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unharmed
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while
heat-resistant
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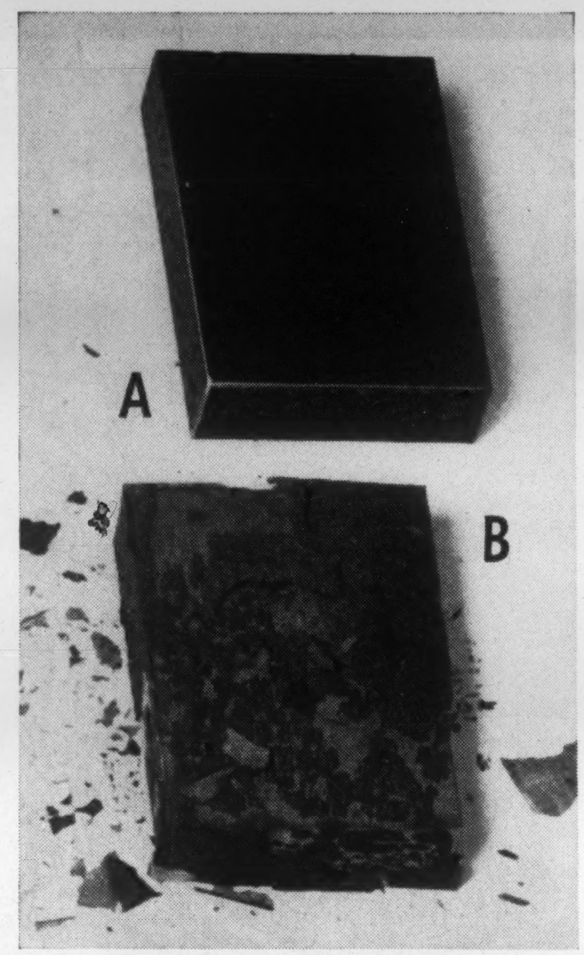
alloy
disintegrates



(Photo A) Kentanium shows only slight oxidation after test and is good for many more hours' exposure at 2000°F. (Photo B) Hard nickel-chromium (35%) alloy is badly oxidized and began to disintegrate during test.

Exceptional resistance to oxidation, combined with great strength at very high temperatures, are characteristics of Kentanium, a titanium carbide composition. Here's proof.

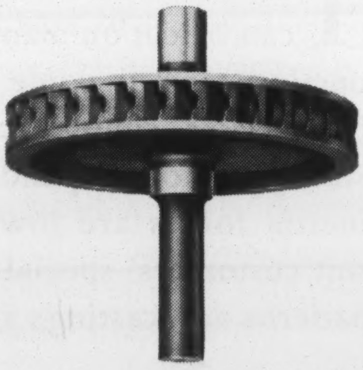
A square of K161B Kentanium and a similar square of a well-known, heat-resistant 35 chromium-15 nickel alloy were exposed for 120 hours in an unsealed muffle furnace heated to 2000°F. The accompanying photographs vividly show how each piece was affected. While Kentanium is still good for hours of exposure at high temperatures, the nickel-chrome alloy has oxidized badly and has begun to disintegrate.

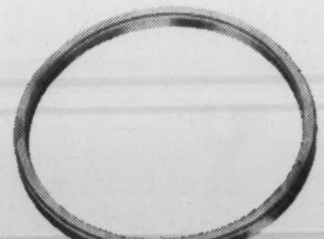
This demonstration suggests how well Kentanium will perform in such applications as furnace parts, heat-treating fixtures, quench guide rings, turbine blades, nozzle vanes, bushings and other parts where strength at high temperature, plus high resistance to oxidation, are factors.

Parts illustrated above are typical applications of Kentanium. The Kentanium series represents only a part of Kennametal's wide range of hard carbide compositions that are helping designers who require metals offering high resistance to abrasion, deflection, deformation, impact or corrosion. Perhaps one or more of these Kennametal compositions will help you get your idea off the drawing board into production. These materials are described and many applications discussed in two booklets: B-111-A—"Characteristics of Kennametal," and B-222—"Designing with Kennametal."

Write KENNAMETAL INC., Latrobe, Pa.

*Registered Trademark B-5976





INDUSTRY AND KENNAMETAL
...Partners in Progress

See our catalog in Section 1b/Ke, Product Design File, Sweet's Catalog

For more information, turn to Reader Service Card, Circle No. 492

PRICES AND SUPPLY

FINISHED STEEL ($/cwt)

Form	Carbon	High Str Low Alloy	Alloy
Plate	4.85	7.25	6.85
Sheet, H.R.	4.67	6.90	—
Sheet, C.R.	5.75	8.52	—
Strip, H.R.	4.67	6.95	7.75
Strip, C.R.	6.85	10	14.55
Bar, H.R.	5.07	7.42	6.12
Bar, C.F.	6.85	—	8.32

STAINLESS STEELS ($/lb)

Material	Forging Billets	H. R. Bars	Plate[b]	Sheet, Strip
Austenitic				
301, 302, 302B, 303, 304, 305	.36-.40	.41-.46	.45-.49	.50-.56
321[a]	.45	.53	.58	.63
347[a]	.54	.62	.67	.76
Martensitic				
410[a]	.27	.33	.34	.39
416	.28	.33	.35	.47
403	.31	.36	.39	.47
420, 440	.32	.40	.44	.60
Ferritic				
405, 430, 430F[a]	.28-.29	.33-.34	.35-.36	.39-.50
442	.32	.38	.40	.54
431	.36	.43	.44	.54
446	.38	.45	.46	.67
High Mn				
202[a]	.35	.41	.43	.47
Extra-Low C				
304L	.47	.53	.56	.61
316L	.64	.74	.78	.82
Precip Hard.				
17-7PH	.55	.65	.72	.77-.82

[a] Ingot prices approx 60% of forging billet price.

METAL POWDERS ($/lb)[a]

Sponge Iron	.09-.10
Electrolytic Iron	
Annealed (99.5%)	.37
Unannealed (99+%)	.34
Stainless Steel	
304	1.05
316	1.44

[a] Price for —100 mesh.

IRON ($/gross ton)

Pig	64.50-65.50

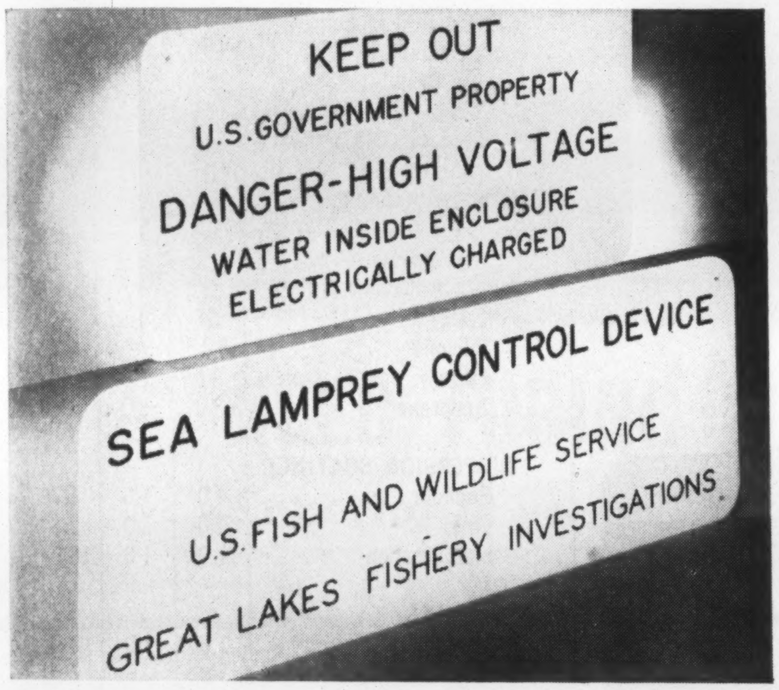
(continued on p 292)

CYANAMID

PLASTICS NEWSFRONT

SOCKETS TO MATCH YOUR '57 CHRISTMAS TREE

A more colorful Christmas—1957 is in the making today. To match the trend to Christmas trees sprayed in a host of colors, Conart Co., Inc., is now molding light socket husks in a variety of colored BEETLE® Molding Compounds to be strung on matching wire strands. Sturdy, hard BEETLE is an excellent insulator, and its molded-in color resists heat and discoloration, can't chip off. Conart produces enough husks each month to stretch twice from coast to coast.


KEEP OUT
U.S. GOVERNMENT PROPERTY
DANGER-HIGH VOLTAGE
WATER INSIDE ENCLOSURE
ELECTRICALLY CHARGED
SEA LAMPREY CONTROL DEVICE
U.S. FISH AND WILDLIFE SERVICE
GREAT LAKES FISHERY INVESTIGATIONS

LAMINAC® SIGNS WARN OF "OPERATION ELECTROCUTION"

These LAMINAC signs point to a great experiment in sea lamprey control being conducted by U.S. Fish and Wildlife Service in the Great Lakes area. To kill these destructive eellike fish, electrically charged lines are stretched across areas where lampreys return from spawning. Passers-by are warned off by signs posted on land and in the water. To make them waterproof, with warnings that can't wash off, Perry Plastics, Inc., makes the signs of glass-reinforced LAMINAC Polyester Resin. Color is molded in, so signs never need painting and will never rot or rust away.

ANGELIQUE'S CYMEL® AEROSOL WINS CSMA AWARD

1956 saw the first successful all-plastic aerosol spray dispenser made of CYMEL Melamine Molding Compound. And it brought the top Chemical Specialties Manufacturing Association, Inc. award in the class of glass and plastic aerosols to Angelique's CYMEL dispenser for Black Satin Spray Cologne. Plastic aerosols are popular with the ladies, too—feel warm and pleasant in the hand, resist breakage and corrosion, eliminate evaporation. Their success points the way to many new packaging possibilities with CYMEL.

1956 Award
Angelique & Company, Inc.
Angelique Black Satin Spray Cologne
Chemical Specialties Manufacturers Association, Inc.

AMERICAN CYANAMID COMPANY
PLASTICS AND RESINS DIVISION
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CYANAMID
Plastics and Resins Division
MATERIALS FOR TOMORROW

For more information, turn to Reader Service Card, Circle No. 589

THOMPSON HELPS YOU LIFT LARGER LOADS FASTER!

1/2 TON
CM
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Revolutionary . . . entirely new CM Electric Hoist with housing designed for greater strength and ruggedness made possible by light metal castings.

WHEN the Chisholm-Moore Hoist Division of the Columbus McKinnon Chain Corporation needed light weight castings for their all new CM Lodestar they turned to Thompson's creative Light Metals Division.

Working together, Chisholm-Moore and Thompson came up with well designed and engineered housing castings that made possible a well manufactured hoist which, when completely assembled, weighs only 50 pounds! In addition, the entirely new, more efficient CM Lodestar Electric Hoist is manufactured with truly significant savings in production costs resulting in a better product at no increase in cost!

This cooperation is typical of Thompson Light Metals Division's close work with many diversified industries. Regardless of *your* product, if you use castings or impact extrusions, our engineers will be glad to show you how *you* can reduce costs with Thompson's Light Metal Castings.

We want to quote on your plans and specifications. Write, wire or phone Dept. MM-5, Light Metals Division, Thompson Products, Inc., 2269 Ashland Road, Cleveland 3, Ohio, HEnderson 1-6765.

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LIGHT METALS DIVISION

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DAvenport 63427

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TIN PLATE ($/base box)

Hot Dip (1.25-1.50 lb)	10.05-10.30
Electrolytic (0.25-0.75 lb)	8.75-9.40
Black Plate	7.85-7.95

FINISHES AND COATINGS

ORGANIC COATINGS

Material	Avg Thk per Coat, mil	Mils Required[a]	Cost, ¢/sq ft/dry mil[b]
VARNISHES, ENAMELS			
Short Oil Phenolic			
Varnish	1.0	1.0	1.50
Enamel	1.2	1.0	1.75
100% Phenolic	1.0	1.5	1.75
Straight Oil-Modified Alkyd	1.5	1.5	1.50
Alkyd-Amine (90-10)	1.5	1.5	1.75
Alkyd-Phenolic (50-50)	1.5	1.5	1.75
Alkyd-Vinyl (50-50)	1.0	2.0	2.0
Alkyd-Styrene (70-30)	1.2	1.5	1.75
Epoxy	1.8	1.8	2.00
Silicone	.5-1.0	.5-1.0	6.0
Furane	2.0	2.0	1.0
Neoprene	5.0	5.0	1.50
DISPERSION COATINGS			
Phenolic	1.0	1.5	1.75
Vinyl	1.0	2.0	2.50
Fluorocarbon	1.0	1.0	15.0
LACQUERS			
Nitrocellulose	1.0	2.0	2.50
Vinyl	1.0	2.0	2.50
Acrylic	1.0	2.0	2.75

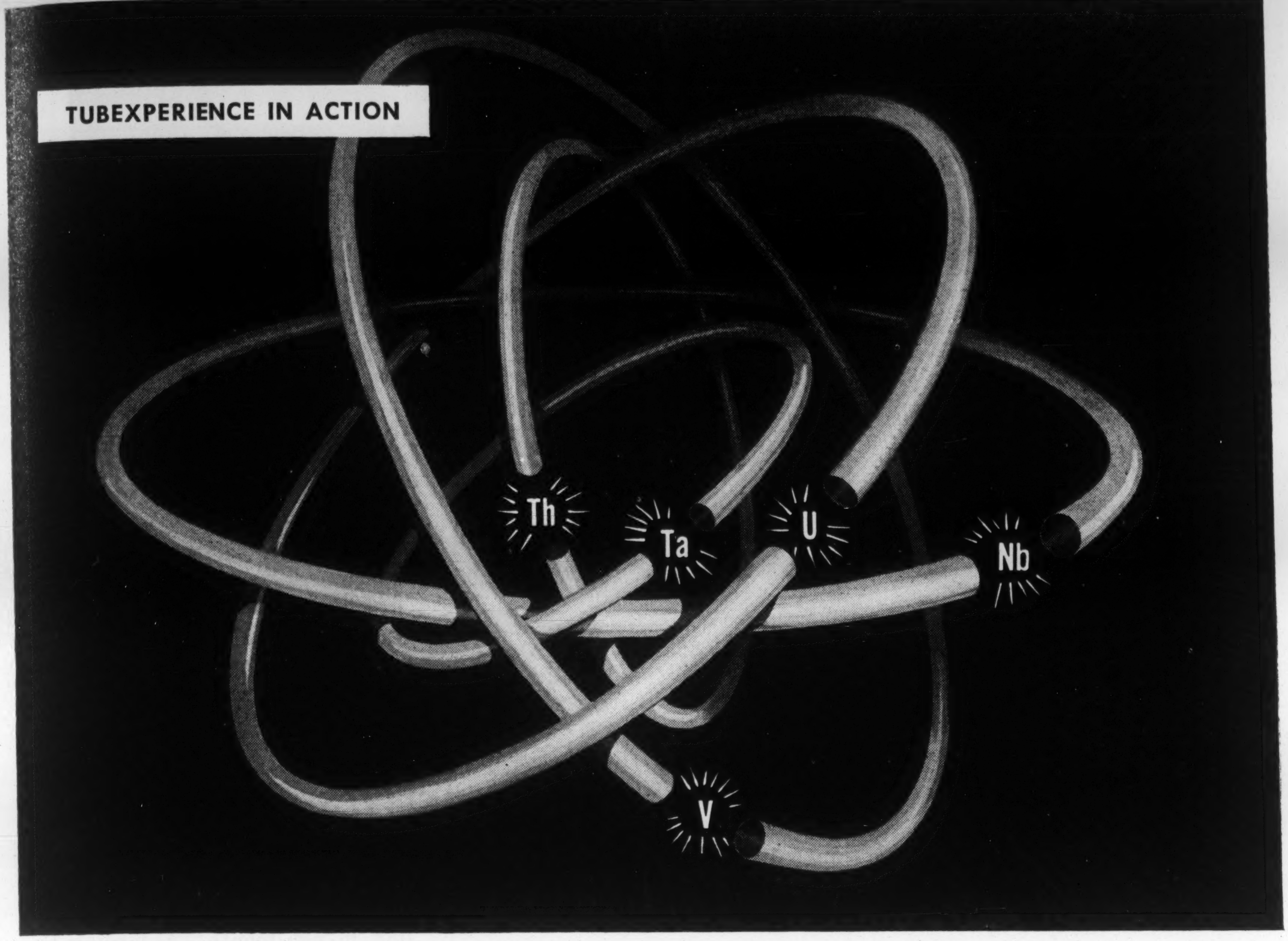
[a] Thickness over phosphate coating required for exterior durability on steel. For purely decorative coating, 1 mil will usually suffice.

[b] Materials cost only. Realistic price comparison can be made only on basis of dry applied coating, not on basis of cost per gallon.

Two Major Producers Up Titanium Production

Titanium production continues to increase at phenomenal rates (see M&M, Mar '57, p 240). News of large expansions has come from Mallory-Sharon Titanium Corp. and Electro Metallurgical Co., div. of Union Carbide and Carbon Corp.

With its major plant expansion



NEED TUBING FOR ATOMIC POWER?

Superior is your most reliable, experienced source

PROOF:

- *Superior has supplied millions of feet of tubing for atomic applications to many of the key manufacturers in the atomic field.*
- *Superior has already successfully manufactured tubing from uranium, vanadium, niobium, tantalum and thorium.*
- *Superior has 9 years' experience in drawing tubing from titanium and titanium alloys.*
- *Superior was the first mill to produce tubing from Zirconium, Zircaloy-2, and Zircaloy-3.*

. . . And Superior has produced all this tubing to exceptionally precise specifications and tolerances!

Put Superior's experience and facilities to work for you! Superior has drawn most of the reactive metals, as well as stainless steels, nickel alloys, ingot iron, and Inconel, for important nuclear applications.

The end uses for Superior tubing in atomic energy include control rod tubing, fuel element tubing, tubing for moderator and shielding cans, process lines for handling radioactive liquids, and tubing for handling facilities.

NOTE: In some cases, tubing can be produced only with AEC release, because of priorities on materials.

If you are in or serving the atomic industry and need small tubing, this store of experience can be of great assistance to you. For information, write Superior Tube Company, 2006 Germantown Ave., Norristown, Pa.

SEND FOR LATEST DATA ON ZIRCONIUM—*Write for your free copy of Special Analysis Memo 112—on zirconium, covering properties, fabrication and other data.* VISIT BOOTH 414 AT THE DESIGN SHOW

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The big name in small tubing
NORRISTOWN, PA.

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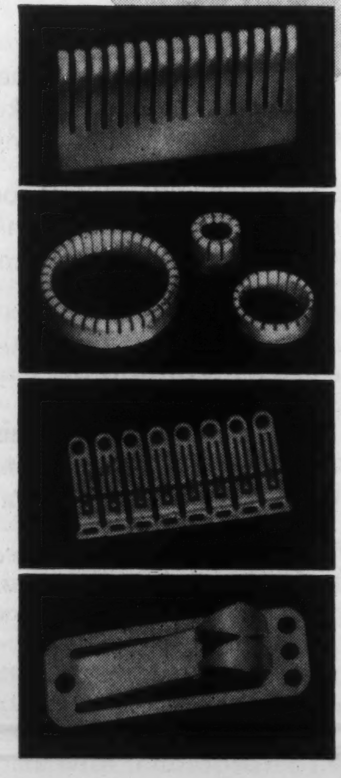
to meet your most exacting spring specifications



For High Strength and High Endurance — specify microprocessed I-S springs of beryllium copper. These unique springs are particularly suited for applications requiring non-magnetic, corrosion-resistant properties, with excellent electrical conductivity, and stability. The inherent advantages of this ideal spring material — combined with I-S specialized engineering techniques in manufacture — assure absolute conformity to your critical spring requirements.

I-S Design Service saves you time and money! For recommendations on specific spring problems, check with I-S. Samples and short runs can be supplied quickly and economically!

For Additional Information consult Sweet's Product Design File or write for our latest Catalog.

INSTRUMENT SPECIALTIES CO. INC.
224 Bergen Blvd., Little Falls, N.J.
Telephone: Little Falls 4-0280

"MICRO-PROCESSED" I-S BERYLLIUM COPPER SPRINGS

VISIT US AT THE SHOW! SEE THE I-S BERYLLIUM COPPER SPRING EXHIBIT AT BOOTH 632, DESIGN ENGINEERING SHOW, N. Y. COLISEUM

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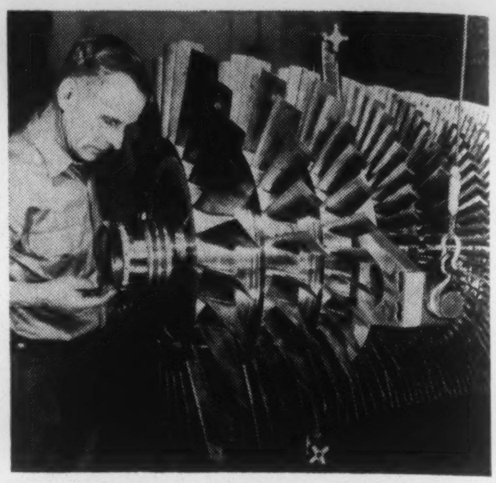
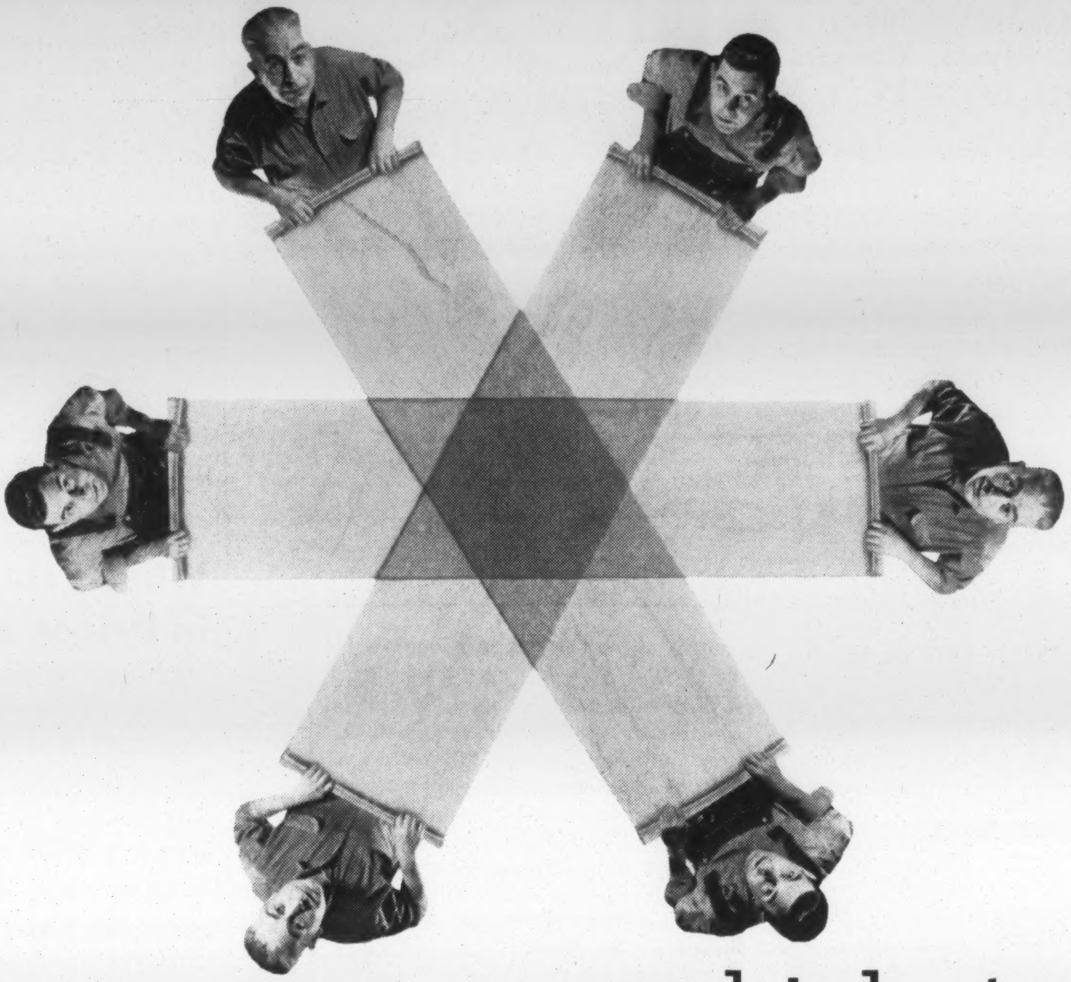


***Continued use of titanium** is forecast by the aircraft industry's need for lightweight, corrosion resistant parts such as this low compressor rotor produced by Pratt & Whitney for the Navy's F8U Crusader.*

just about completed, Mallory-Sharon Titanium Corp. expects its titanium melting operations to shortly reach the rate of one million lb per month. According to James A. Roemer, president, the company expects to produce a total of 3500 tons of sheet, strip, rod, bar and other mill products in 1957—more than twice the company's output in 1956.

Electro Metallurgical Co. recently announced that its new titanium sponge plant, considered to be the largest in the world, has reached capacity production. According to A. L. Foscue, president, the plant will produce 7500 tons of titanium sponge annually. Mr. Foscue says production of titanium sponge in the United States is expected to approach 30,000 tons annually by the end of 1957. Production in 1956 was estimated at 13,000 tons.

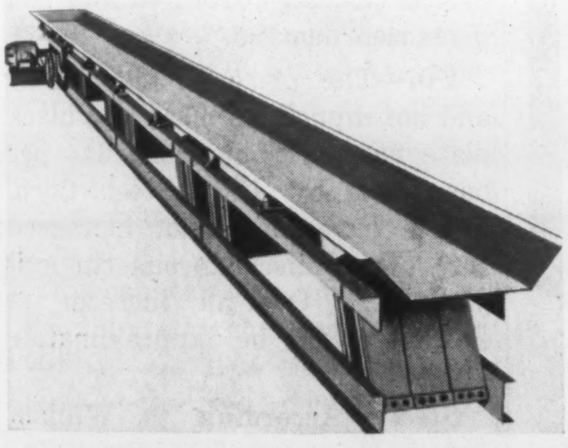
In addition to expansion of facilities, both companies are engaged in research aimed at improving the metal. Mallory-Sharon, for example, reports that it has developed new weldable, heat treatable alloys which it will introduce sometime in 1957. Electro Metallurgical Co. was the first to produce titanium metal sponge commercially by the sodium reduction process rather than the



3M announces a new high-strength, lightweight structural material

NOW..."Tailor-make" strength for specific stress jobs

"SCOTCHPLY" Brand Reinforced Plastic is a high-strength, moldable, laminated structural plastic reinforced with continuous, non-woven glass filaments. Now, Design Engineers are able to tailor the direction of reinforcements to satisfy specific stress requirements. This versatility is not possible with conventional reinforced plastics using woven glass cloth or short strand reinforcement.



LEAF SPRINGS of "SCOTCHPLY" Brand Reinforced Plastic have higher fatigue-strength than steel and are highly resistant to corrosion and moisture. Here they supply 90% of the operating power for a Carrier "Natural-Frequency" vibratory conveyor.

STRENGTH WHERE NEEDED—Continuous, non-woven glass filaments can be unidirectional, crossplied at 90° in two directions, isotropic at 120° in three directions or arranged in combinations of these directions—depending on stress conditions. Isotropic arrangement (illustrated above) gives equal strength in all directions in the plane of the laminate.

HIGH STRENGTH, LOW WEIGHT—Supplied in uncured sheets or rolls "SCOTCHPLY" Reinforced Plastic has high strength. Weight-to-strength ratio is lower than conventional structural materials, including steel.

EASILY WORKED—Heat and light pressure are all that's needed to cure it. In cured form it can be sawed, machined, sanded, milled, turned, drilled or tapped.

EXCEPTIONAL UNIFORMITY—"SCOTCHPLY" Reinforced Plastic is *mechanically* processed under carefully controlled conditions, eliminates human variables. Its properties can be specified within very narrow limits—unlike other reinforced plastics where *hand* lay-up is necessary.

PLUS—It is a non-conductor . . . has low rate of moisture absorption . . . may be permanently colored or painted . . . gives high resistance to vibration, shock and corrosion . . . has hard, smooth surface.

FOR FULL INFORMATION AND TECHNICAL DATA, WRITE MINNESOTA MINING & MANUFACTURING CO., DEPT. PB-57, ST. PAUL 6, MINN.

The term "SCOTCHPLY" is a registered trademark of Minnesota Mining and Manufacturing Company, St. Paul 6, Minn. Export Sales Office: 99 Park Ave., New York 16, N.Y. In Canada: P.O. Box 757, London, Ontario.

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SCOTCHPLY

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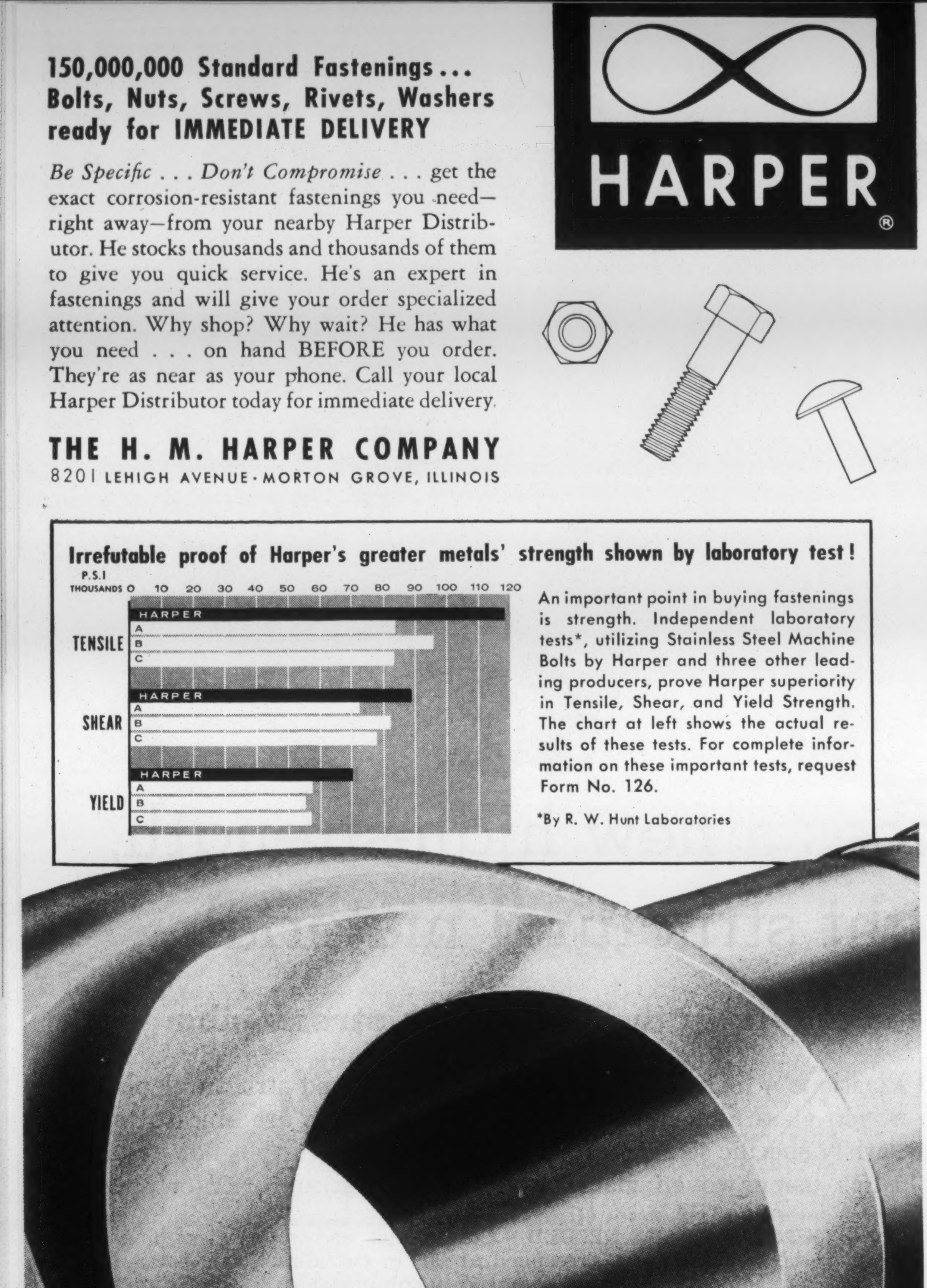

**150,000,000 Standard Fastenings . . .
Bolts, Nuts, Screws, Rivets, Washers
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Be Specific . . . Don't Compromise . . . get the exact corrosion-resistant fastenings you need—right away—from your nearby Harper Distributor. He stocks thousands and thousands of them to give you quick service. He's an expert in fastenings and will give your order specialized attention. Why shop? Why wait? He has what you need . . . on hand BEFORE you order. They're as near as your phone. Call your local Harper Distributor today for immediate delivery.

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Irrefutable proof of Harper's greater metals' strength shown by laboratory test!

An important point in buying fastenings is strength. Independent laboratory tests*, utilizing Stainless Steel Machine Bolts by Harper and three other leading producers, prove Harper superiority in Tensile, Shear, and Yield Strength. The chart at left shows the actual results of these tests. For complete information on these important tests, request Form No. 126.

*By R. W. Hunt Laboratories

magnesium reduction method.

The consensus is that there will continue to be an increasing demand for titanium which the producers will be hard put to meet.

What's Happening in Prices and Supply

Aluminum — Two large expansion programs are scheduled to get under way in the near future. Reynolds Metals Co. plans to construct a $150 million primary aluminum plant near the St. Lawrence Seaway project and will add to existing facilities.

Aluminum Co. of Canada is offering $125 million debentures in order to raise funds for its expansion program, begun in 1951, which will more than double its capacity.

Platinum—The price of platinum has been reduced by the leading refiner to $92-95 per oz. This is the second reduction in platinum's price this year. The first reduction, in January, amounted to $4 per oz. The latest reduction, $6 per oz, is attributed to lower priced offerings from Russia and decreased demand.

Tin—The price of electrolytic and hot dipped tin plate and black plate has been increased 35¢ per base box by U.S. Steel Corp. Prices have also been increased for "other miscellaneous tin mill products." Over-all increase is estimated to be approximately 4½%.

Steel — According to William Butler III, of Lukens Steel Co., the steel industries of the world may nearly double their production capacity in the next 25 years. He gives as reasons for this the demands for steel by industries requiring nuclear power. In 25 years, he points out, world capacity "will have reached 625 million tons. The United States is expected to hold its place as the world's leading producer with

◄ For more information Circle No. 552

40% of that capacity, or 250 million tons."

Silicon—Three grades of silicon semiconductor materials — research, premium and standard—will be made available for commercial use by Texas Instruments, Inc.

Cellophane—Both Du Pont and American Viscose Co. have raised cellophane prices by approximately 5%. This brings the price of the most widely used types to 62¢ per lb.

Du Pont has also announced plans for the construction of a new cellophane plant near Tecumseh, Kansas. The plant will produce 50 million pounds of cellophane per year.

Vinyl chloride — Diamond Alkali Co. will build a plant to produce 50 million pounds of vinyl chloride monomer annually.

Iron Powder Use Up, Supply Plentiful

Iron powder consumption continues to rise at a phenomenal rate. In the last ten years usage increased from 2000 tons in 1946 to an all-time high of 32,500 tons last year. Production of iron powder in the United States has also increased greatly. In fact, iron powder imports are decreasing steadily.

For example, in 1954 nearly one-half of the powder consumed in this country was imported. In 1955 the ratio changed to about one-third. In 1956 the trend continued to the point where 70% of the iron powder consumed in this country was manufactured here.

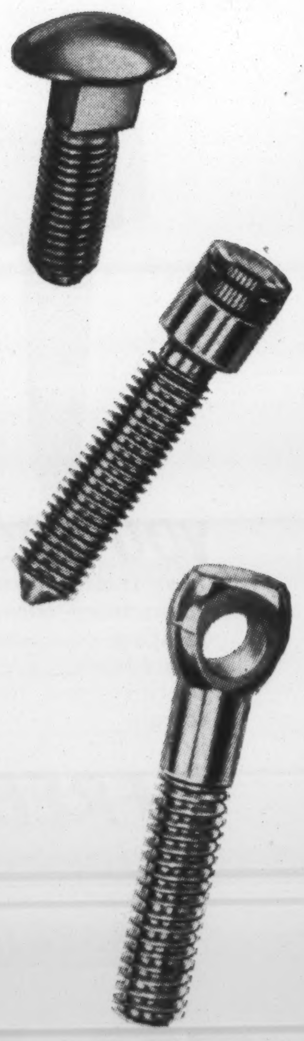
However, the increase in production has not been consistent with the increase in consumption. In 1953 U. S. capacity was 13,600 tons. In 1956 capacity jumped to 48,500 tons — approximately 1½ times greater than present demands, according to Metal Powder Assn. figures.

For more information Circle No. 553 ➤

HARPER ®

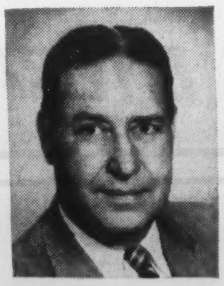
CORROSION-RESISTANT FASTENINGS

Put your SPECIAL problem to the Harper FLO-FORM team



This small but tricky eyebolt (reproduced here in giant size) was redesigned and produced by Harper at a 50% saving. The Harper Flo-Form Process employs highly special techniques to produce parts of economical design, , with greater strength and durability, and *without* scrap loss. Call on the Harper Flo-Form engineering team of design, metallurgical, and tooling specialists to help you save dimes to dollars on parts which you find costly to manufacture. Use their more than 33 years of know-how. See what you, too, can save on corrosion-resistant fastenings and special parts. Send your problem today to The H. M. Harper Company and ask for the Flo-Form catalog.

Meet HENRY MULLANEY,
Harper Application Engineer



Philadelphia design and production engineers who have called upon Mr. Mullaney for assistance with fastening problems know the value of his advice and counsel. Henry typifies the experience that can be applied to your fastening problems through Harper Flo-Form Engineering Service.

THE H. M. HARPER COMPANY
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The Harper infinity symbol, as shown above, and the name FLO-FORM are registered trade marks of The H. M. Harper Company.

GET "Uniformity of Austenitizing Cycle, Absolute Control of Surface Chemistry, Minimized Handling Damage"

George W. Lyman, Chief Engineer, Reed Rolled Thread Die Co.

HERE'S WHY...

REED ROLLED THREAD DIE COMPANY CHOSE HAYES EQUIPMENT TO HEAT TREAT THREAD ROLLING DIES . . .

The Reed Rolled Thread Die Company of Holden, Mass., recently installed a Hayes LAC furnace equipped with Hayes Ampro process atmospheric control to heat treat their flat, cylindrical and planetary thread rolling dies made of high carbon-high chrome steel.

Uniformity of the austenitizing cycle, absolute control of the thread surface chemistry, and reduced possibility of damage to the thread crests of the dies are the outstanding features which led to the selection of Hayes equipment and process.

Temperature in the three zone heating and the water-jacketed cooling sections of the furnace is closely controlled. Scaling of the dies has been eliminated, and the carbon content of the die surfaces is controlled by using dew point measurements to regulate the proportions of dissociated ammonia and propane in the furnace atmosphere according to the Hayes formula. By heating and cooling in the same piece of equipment, objectionable handling damage is minimized.

YOU TOO... can find the ideal solution to your heat treating problems at C. I. Hayes. The unique Hayes Laboratory contains an extensive line of production heat treating equipment on which to develop customized plant procedures. If existing equipment does not meet YOUR specifications, new equipment will be designed and built to suit.

YOU TOO... can be assured of GUARANTEED RESULTS designed to improve your product, increase output, and reduce unit costs. Let us show you what over fifty years experience in developing the well known line of CERTAIN CURTAIN electric furnaces and allied equipment can do for you. Write today!

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Please send complete data. I am mostly concerned with the following heat treating procedures.

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☐ Tool Steel Hardening
☐ Carbo-Nitriding
☐ Tempering
☐ Vacuum Heat Treating
☐ Bright Heat Treating
☐ Stainless Steel Heat Treating
☐ Sintering
☐ Copper Brazing and Soldering
☐ Lead Pot Hardening and Tempering
☐ Atmosphere Equipment
☐ Other..........

Name.......... Title..........
Company..........
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For more information, turr. to Reader Service Card, Circle No. 531

News OF INDUSTRY

Digital computer *is used to store and retrieve bibliographic information in new research center.*

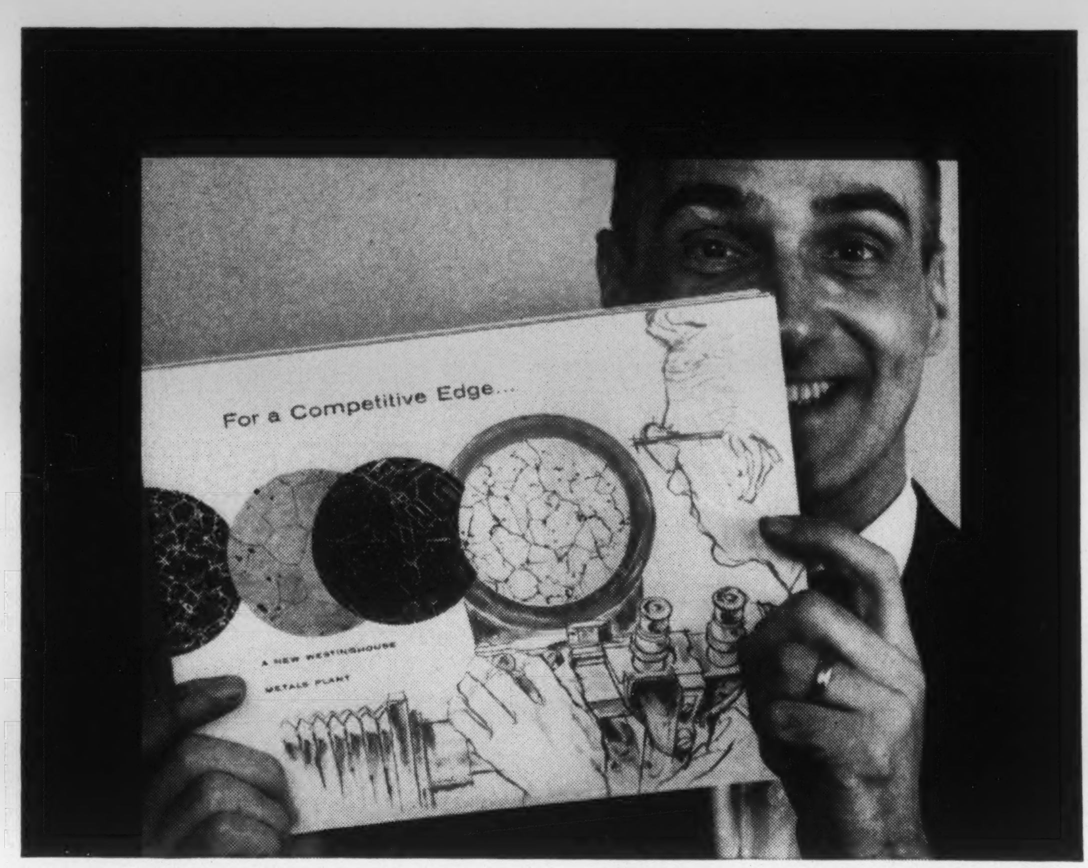
Thermophysical Properties Studied in New Research Center

■ A new research center devoted exclusively to the study of thermophysical properties of materials has been established at Purdue University. Under the immediate direction of Dr. Y. S. Touloukian, professor of mechanical engineering, the long-range objective of the center is to serve as a world center for research and for the collection, analysis, correlation and dissemination of data on thermophysical properties.

Slated to be fully equipped and staffed by the fall of this year, the center will start a three-year program which will be confined to seven essential thermophysical properties: thermal conductivity; viscosity; specific heat; thermal emissivity, absorptivity and reflectivity; mass diffusivity; thermal diffusivity; and Prandtl number. In terms of materials to be studied, the program will concern itself, in a relative and gradual order, with properties of gases, liquids and solids, starting with the technically more important materials and substances. Other criteria for selection of substances and properties will be: 1) demand for information on a given property, 2) paucity or abundance of available data, and 3) degree of discord, if any, in a given area.

Analytical research

The analytical research phase of the program will consist of: 1) critically evaluating, unscrambling, reconciling and correlating all available data on one property and one material (or a group of materials) and arriving at an internally consistent set of tables, which can be termed "most probable values"; 2) filling in gaps and extending available experimental data over higher or lower ranges of temperatures and pressures by means of semi-empirical or theoretical considerations; 3) generating tables of transport values of gases (particularly of gas mixtures) on the basis of statistical thermodynamics wherever experimental data on such properties are nonexistent or nearly so; and 4) preparing graphical representations of "most probable values" for each property, comparing



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The booklet takes you on a tour of the new Westinghouse metals plant at Blairsville, Pa. Pilot plant facilities here can help you explore full production conditions and create prototype quantities for wrought alloys and molded-metal products. Some production capacity can be made available for fast, dependable delivery of metal products.

Arrange to see the 16-mm, full-color, 22-minute Westinghouse film, *This New World of Metals*. Write Westinghouse Electric Corporation, Materials Manufacturing Department, Blairsville, Pennsylvania. J-05003

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recommended tabular values with all available experimental data. All work will be periodically reviewed and revised and extended as new information is brought to light.

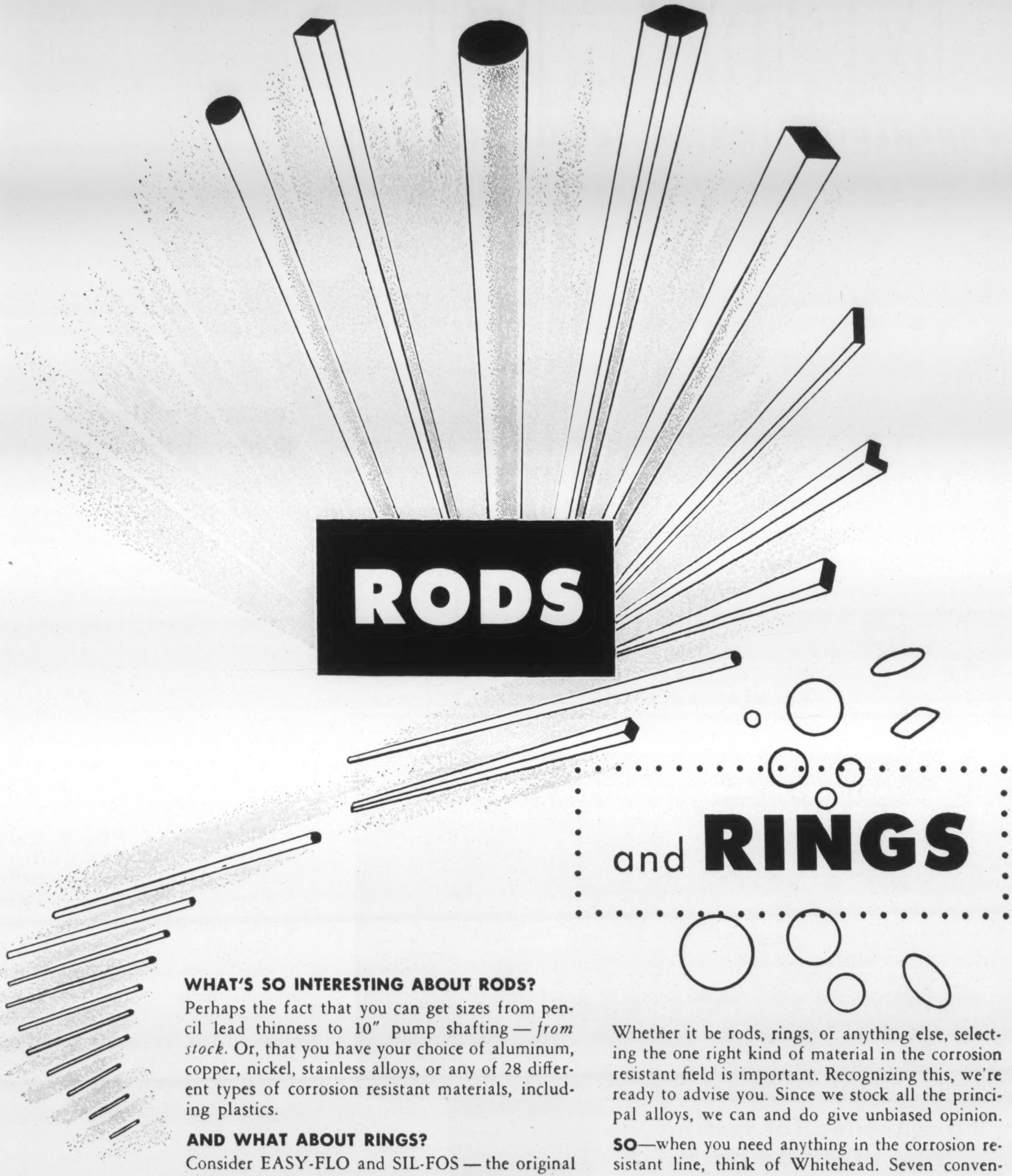
Currently Dr. Touloukian is forming a research staff of trained and experienced personnel in physical chemistry, physics, metallurgy, chemical and mechanical engineering, and library science. When complete, the staff will consist of ten full-time scientists and engineers, constituting a nucleus that will be assisted by graduate students working in this area.

Microscope Examines Radioactive Materials

A new remote-controlled microscope developed by General Electric Co. is capable of studying changes that occur in the microstructure of metals exposed to chain reaction bombardment. The information is used to develop alloys and fabrication methods that will make atomic structures withstand increased radiation exposure.

All work is done remotely inside a 38-ton steel cell which houses the radioactive sample. The sample is placed in the cell by means of mechanical "hands" powered by electric motors. These hands remove the sample from a lead container and position it against grinding and polishing wheels. Electrical etching then removes the top layer of metal (in which the heat of grinding has produced a nontypical microstructure).

Light beamed through a wall port is focused to a bright pinpoint, illuminating the polished metal sample inside the cell. Reflected light from a circular dot of metal, sometimes as small as 0.005 in. in dia, is collected by a compound lens and projected through another wall opening to



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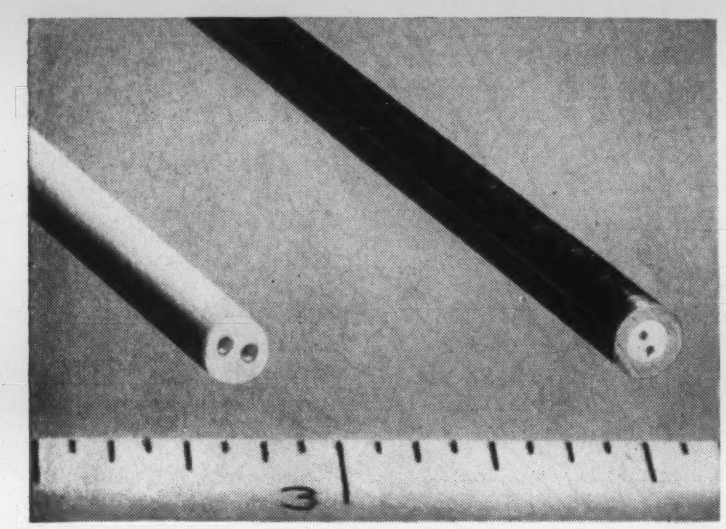

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an external eyepiece. The instrument can optically separate two elements of grain structure 0.0001 in. apart. In effect, it places the observer's eye within 0.004 in. of the "hot" surface and still permits the eye to focus.

Design Problem Solving Subject of ICA Course

The Institute of Contemporary Art is offering a summer program entitled "Processes for Design Problem Solving." The program, formulated with the assistance of officials from the American Society of Industrial Designers, Industrial Designers Institute, Package Designers Council and National Society for Decorative Design, as well as leading architects, designers and educators, has been planned to interest industrial designers, creative engineers, design directors, etc.

Typical of the subjects to be discussed are "Design Initiative" and "Cross Discipline Creativity —a Strategy for Comprehensive Design Research."

The course will run from July 8 to Aug 16. Registration forms and information on tuition fees, living accommodations, etc., can be obtained from Theodore S. Jones, Associate Director, Institute of Contemporary Art, 230 The Fenway, Boston 15, Mass.

Some Die Casting Alloys Made obsolete by ASTM

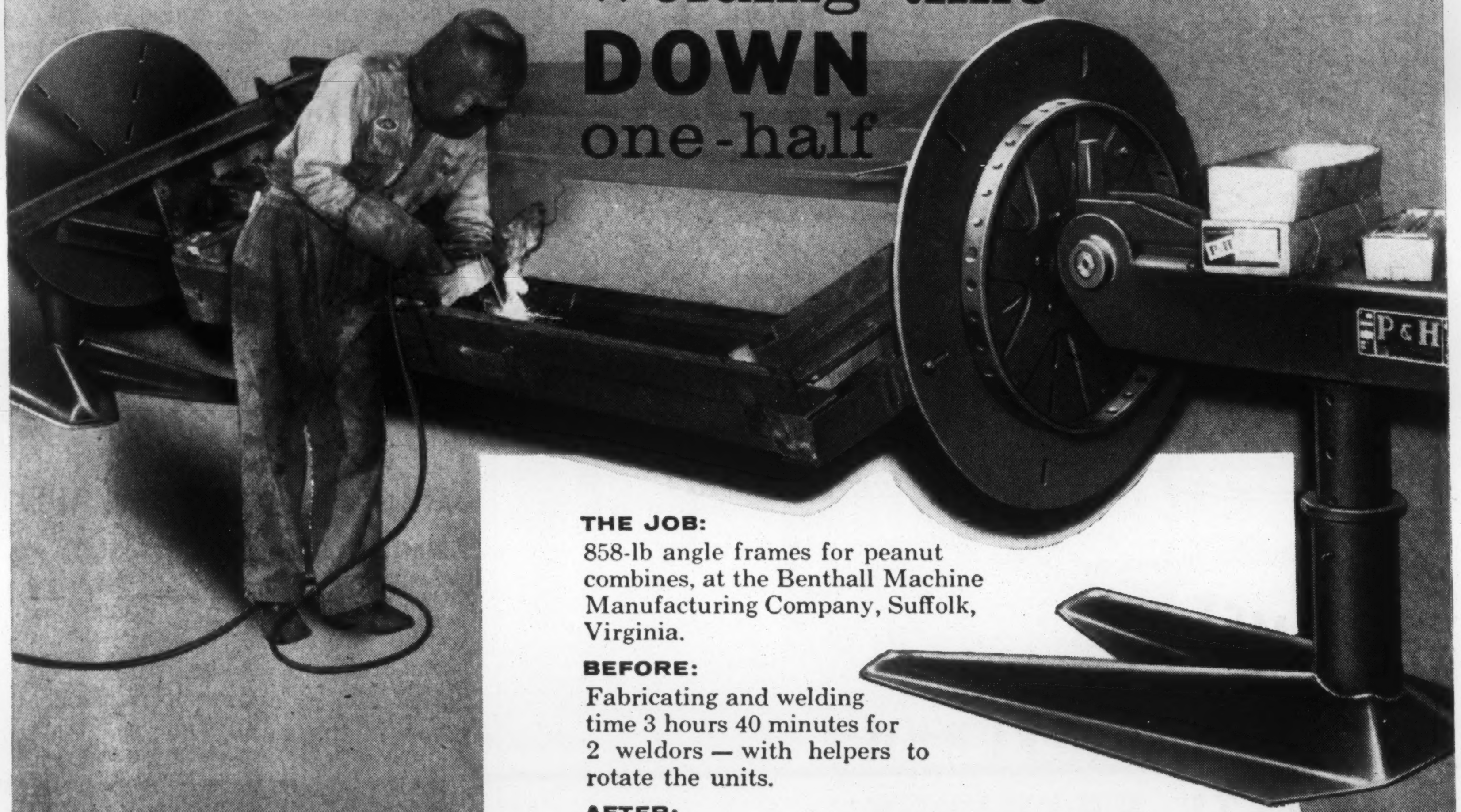
The ASTM committee on die cast metals and alloys has deleted two aluminum-base alloys, a zinc-base alloy and a magnesium-base alloy from ASTM specifications covering die casting.

The group, which met in Philadelphia in February, pointed out that aluminum alloys SC54A and SC54B have been replaced by bet-

a before-and-after story about P&H welding positioners:

production UP 100%

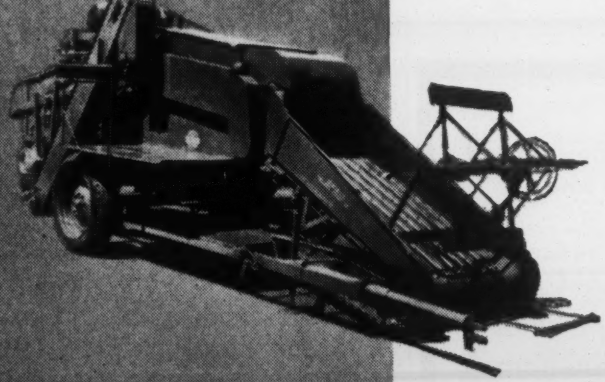
welding time DOWN one-half



THE JOB:
858-lb angle frames for peanut combines, at the Benthall Machine Manufacturing Company, Suffolk, Virginia.

BEFORE:
Fabricating and welding time 3 hours 40 minutes for 2 weldors — with helpers to rotate the units.

AFTER:
By using a P&H welding positioner, time cut to 1 hour 50 minutes — with no helpers, only 2 weldors unassisted.



Here the use of a P&H welding positioner gave the Benthall Company higher-quality down-hand welding and faster weldment handling, enabling them to sharply reduce labor and overhead — the cost factors that take 86¢ out of every welding dollar, today.

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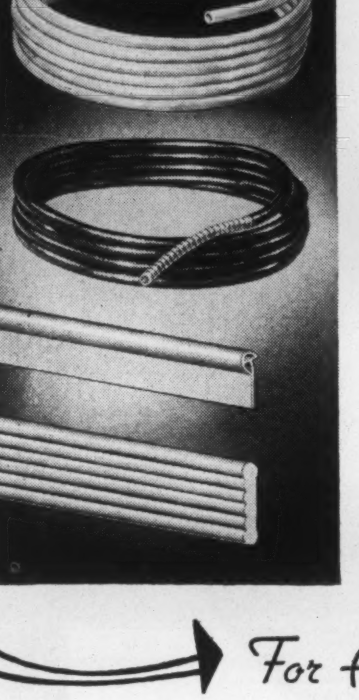

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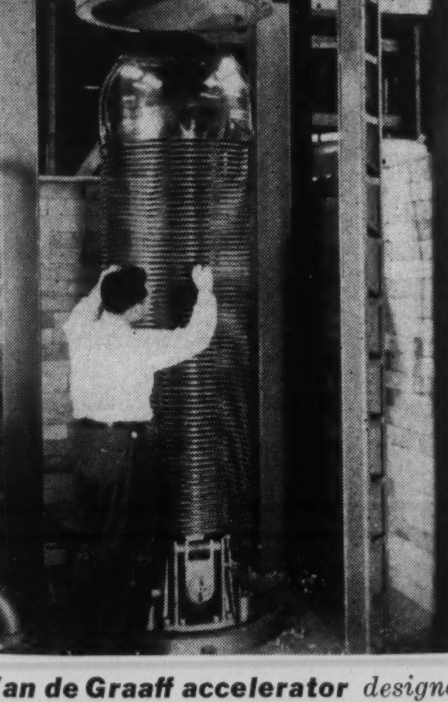
ter alloys and are no longer used. Zinc-base alloy, AC43A, and magnesium alloy, AM100B, were dropped because they "are not as stable as other alloys."

In addition to these deletions, the committee discussed possible changes in specification B86 covering zinc die castings. Changes contemplated include raising the maximum copper limit in alloy AG40A from 0.15 to 0.25% and the addition of a footnote stating that copper in the range of 0.25 to 0.75% will not affect the serviceability of these die castings in most commercial applications.

In process is a note of warning stating that alloy AC41A should not be subjected to long exposure at temperatures above 200 F.

Radiation Facility Aids Industrial Technology

Radiation is occupying an increasingly important position in industrial technology. It is being used for processing and investigation in the metal, chemical, food,



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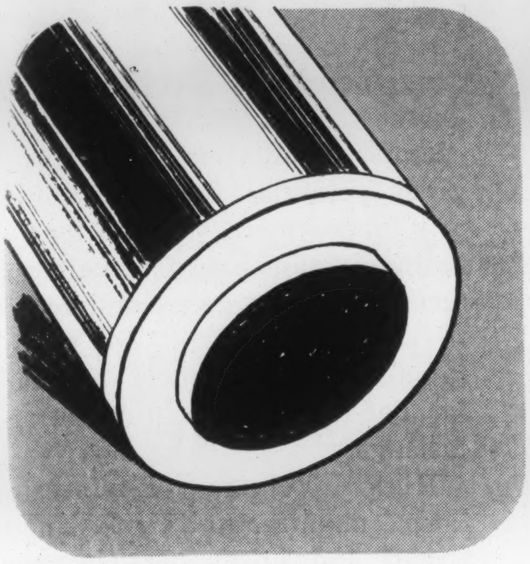
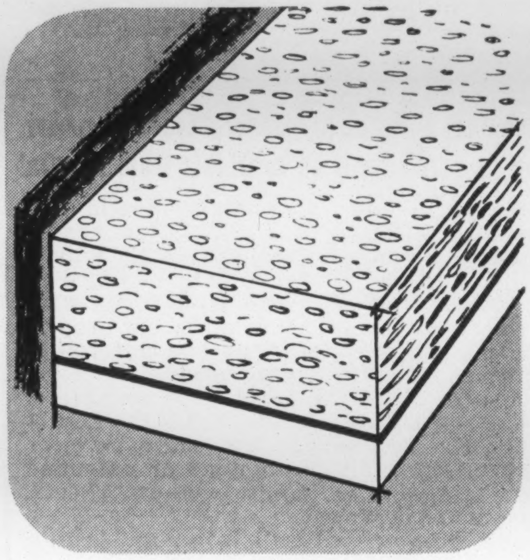
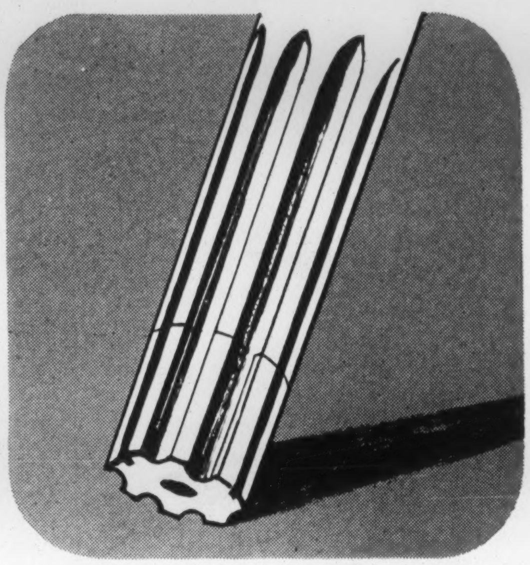


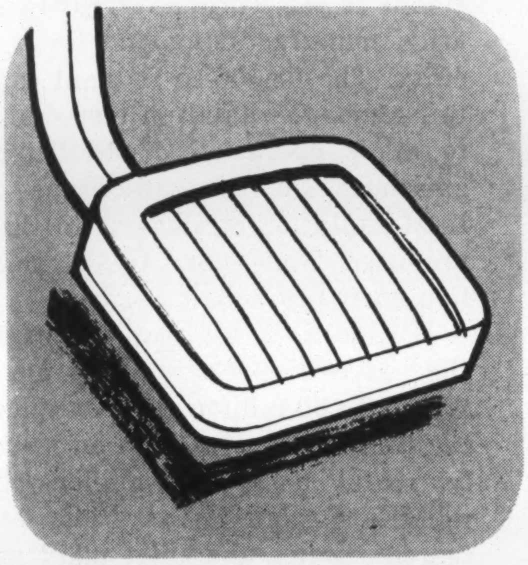
Butyl rubber foot to stainless steel tank



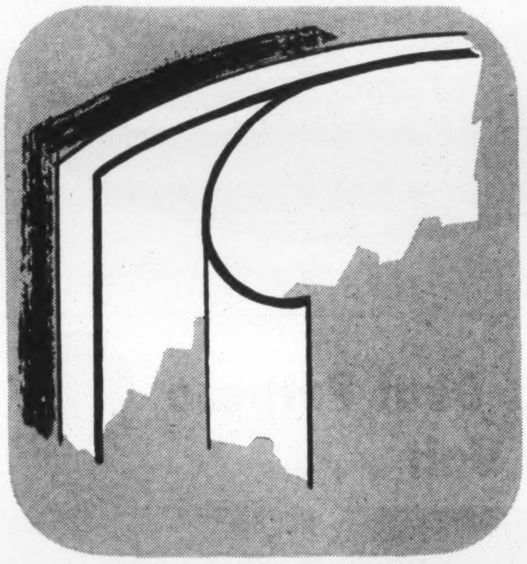
Synthetic foam to metal



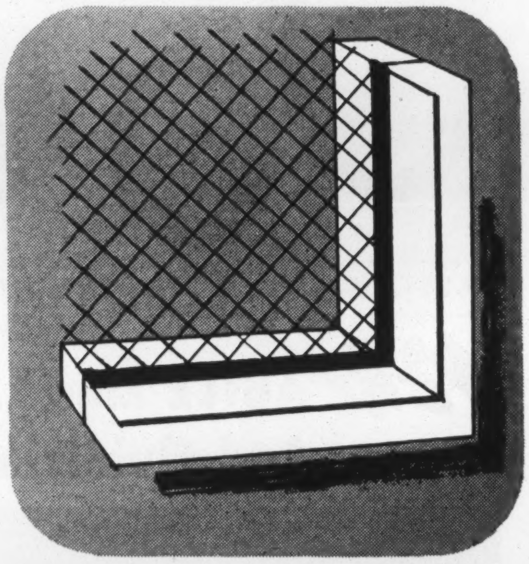
Ceramic tips to steel shanks



Natural rubber to clutch pedal



Etched "Teflon"* to steel



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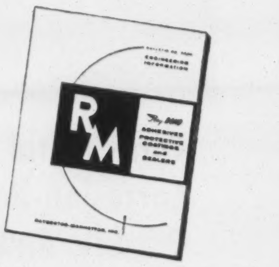
R/M initiated the production of bonded assemblies more than 20 years ago. Over the years we have acquired a wealth of experience that can help you cut costs and simplify operations in innumerable bonding applications. Call on our engineers to work with you in developing adhesives, protective coatings, and sealers to meet your specific requirements. Adhesives Department, RAYBESTOS-MANHATTAN, INC., Bridgeport, Conn.



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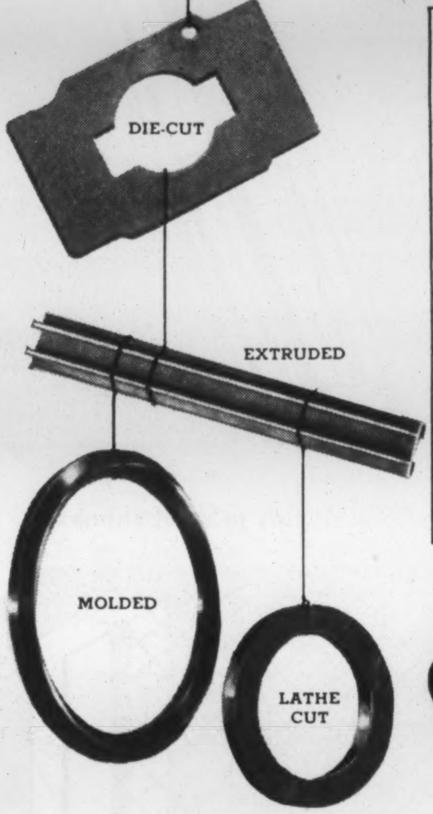

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drug, petroleum and plastics industries. In the plastics field, for example, radiation has shown great potential for cross-linking of high polymers, sterilization and in the irradiation of certain materials to form gases and foams. In the metal field, it has proved valuable for a number of years for detecting flaws in welds and castings.

High Voltage Engineering Corp., manufacturers of Van de Graaff and linear particle accelerators, has completed what it claims is the world's largest radiation manufacturing and test facility. The 88,000-sq-ft plant contains enough radiation test vaults to allow operation of 16 "atom smashers" at the same time—a total radiation equivalent to that produced from more than 3 million curies of cobalt 60.

In addition to manufacturing the accelerators, which range from 1 to 50 million electron volts, the company operates on an hourly rental basis a 2-million-volt radiation facility for basic research studies and pilot plant irradiation of products.

Electrochemical Society to Meet This Month

"Chemical Metallurgy," "The Role of Metal and Oxide Structure in Oxidation and Corrosion" and "Columbium" are among the many current topics that will be covered at the Electrochemical Society's 111th meeting to be held May 12-16 at the Hotel Statler in Washington, D. C.

In addition to the above, sessions will be held on Electric Insulation, Electronics (including luminescence, semiconductors, thermionic cathodes, instrumentation and screen applications), Electrothermics and Metallurgy, Industrial Electrolytics and Theoretical Electrochemistry (including a special symposium on electrolytes).

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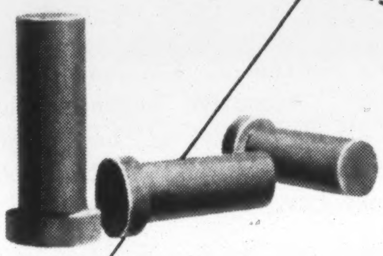
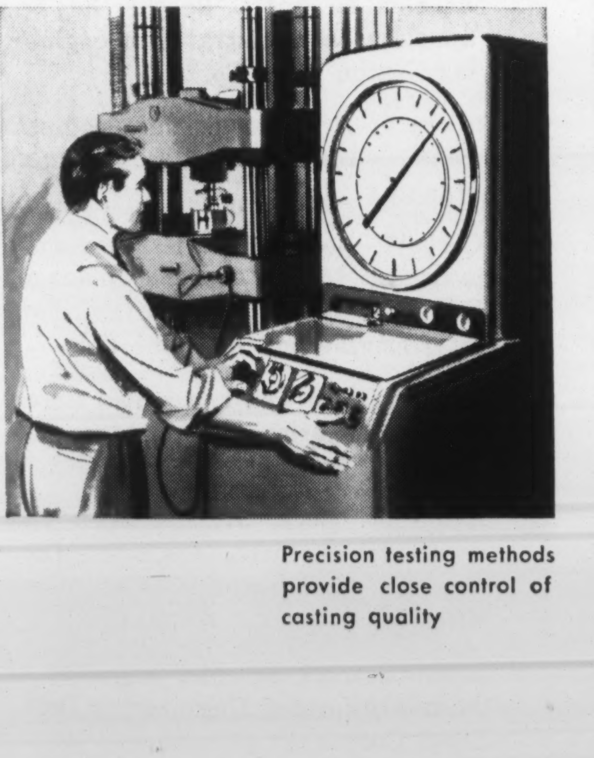


METALS PROCESSING DIVISION FOUNDRY handles wide range of sizes, closely controls dimensions



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Curtiss-Wright's Metals Processing Division today offers your industry precision castings of critical parts in a wide variety of sizes, and with closely controlled dimensions. For example, in the large casting shown, tolerance is ±.030 over 36″ diameter. From its modern, completely equipped foundry in Buffalo, the Division supplies heat, corrosion and abrasion resistant castings from a full range of special-property alloys, including ductile iron...by sand, centrifugal, ceramic or shell processes.

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Relay Support Bracket with
9 holes—two different sizes
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News OF INDUSTRY

Engineers

Eugene A. March is now assistant manager of Crucible Steel Co.'s Sanderson-Halcomb Works. **Robert K. Dunn** succeeds Mr. March as chief metallurgist.

William H. Weed is manager responsible for all activities of the Engineering Dept. of Mutual Chemical Div., Allied Chemical & Dye Corp.

Robert H. Brown is now assistant director of Aluminum Co. of America's Research Laboratories. **Charles J. Walton** is chief of the Chemical Metallurgy Div.

Arthur B. Tillman has been promoted to the newly created position of operations manager, Electro Chemicals Div., Diamond Alkali Co.

Dr. Morton J. Fainman has been named executive engineer for the cobalt-60 project of the Technological Center, Inland Testing Laboratories Div., Cook Electric Co.

Robert C. Anderson, former chief metallurgist, W-K-M Co., is now a consulting metallurgical engineer.

Robert Annan, mining engineer, was awarded the 1957 Egleston Medal on May 9. The medal is Columbia University's highest award for "distinguished engineering achievement."

Lt. Gen. Bryant L. Boatner has been appointed administrator of engineering, Eaton Mfg. Co.

Allen C. Bradham is chief engineer, Penn Instruments Div., Burgess-Manning Co.

Carl W. Bollum, Sr. is engineering assistant to the general manager, Fairchild Guided Missiles Div., Fairchild Engine and Airplane Corp.

Peter R. de Bruyn has joined Revere Corp. of America as application engineering manager.

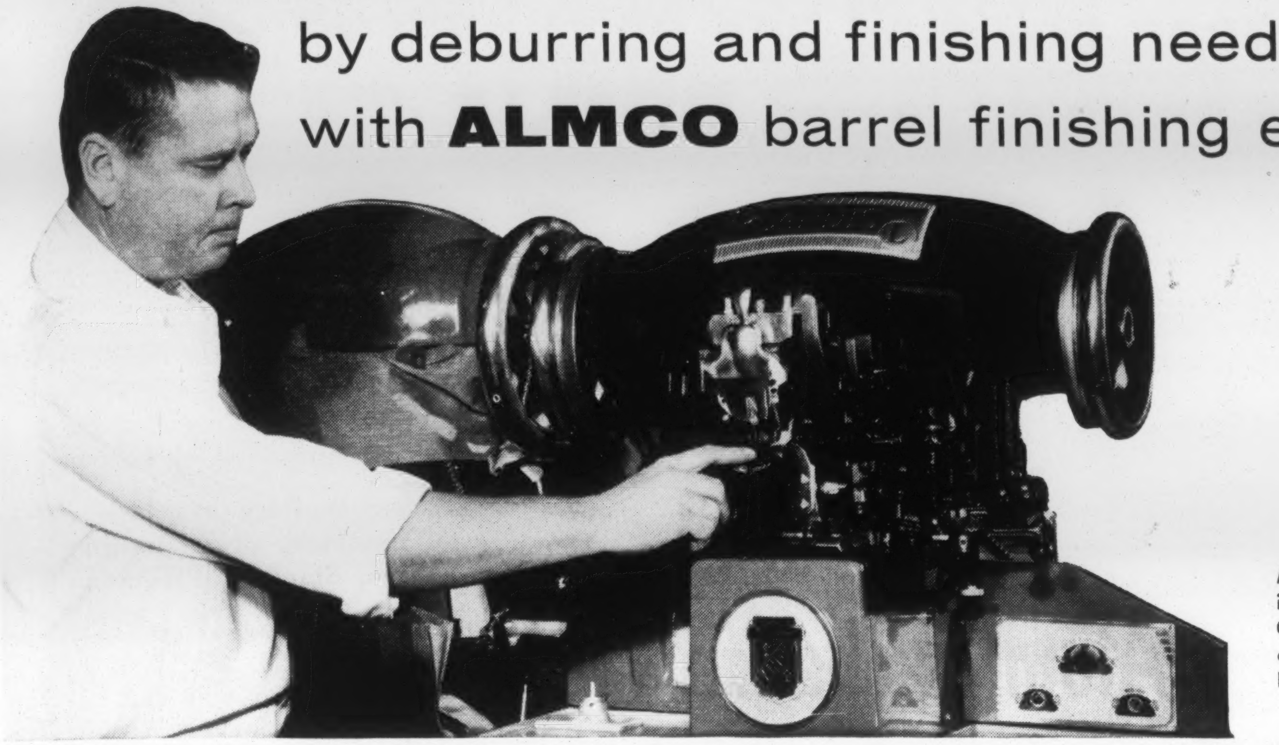
Elmer A. Beck, Jr. has been promoted to executive engineer, Cook Research Laboratories Div., Cook Electric Co.

A. C. Burdick is chief engineer of the newly formed Engineering Dept., Ethyl Corp.

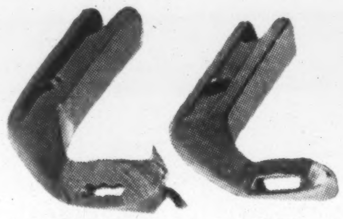
(continued on p 310)

FINISHING ENGINEER AT LANDIS MACHINE CO. REPORTS . . .

"We cut costs from $55⁰⁰ to 55¢ per 100 by deburring and finishing needle plates with ALMCO barrel finishing equipment"



MR. JAMES W. DUNFORD, finishing engineer at Landis Machine Co., St. Louis, points to location of needle plate in new model of Landis shoe repair machine.



One of the most successful barrel finishing applications on record at Almco is this needle plate deburring and finishing at Landis Machine Company.

The needle plate forgings are drilled and broached and then carefully deburred. Formerly the tough burrs were removed by hand filing at a cost of $55.00 per 100.

Now, an Almco Model DB-200 barrel finishing machine performs the same operation at a cost of 55¢ per 100, a savings of 99%!

MANY LANDIS PARTS NOW BARREL FINISHED

With this $3,200 annual savings on needle plates alone in mind, Landis engineers have applied the Almco method to other parts until the company is now barrel finishing several hundred different parts to high quality standards. Rejects are practically non-existent.

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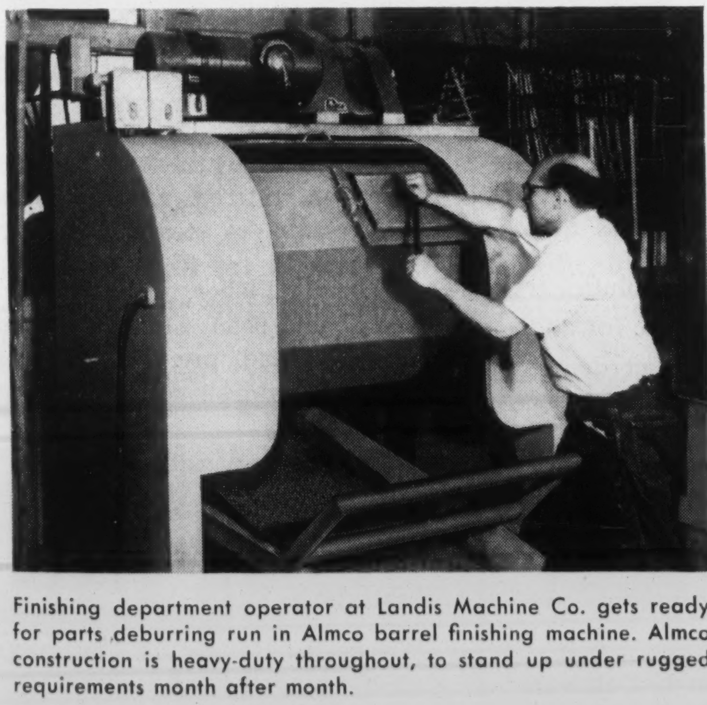
By keeping simple records on processing cycles, correct media and compound, and proper scheduling, Landis engineers can switch the Almco equipment from part to part, to meet plant production requirements exactly.

BROAD EXPERIENCE FOR YOU

Almco's experience in barrel finishing methods and techniques now covers a wide range of parts, sizes, shapes, metals, and operations. Almco maintains sample processing laboratories for the purpose of analyzing product parts and desired results. Let Almco technicians work out procedures to give you the quality you want at the lowest possible finishing cost.

REQUEST YOUR REPORT

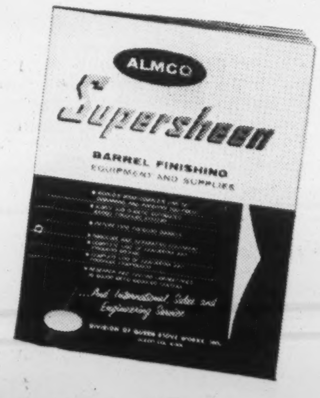
Simply write on your company letterhead, requesting an Almco engineer to call on you. Or, send your sample parts and specifications on results direct to Almco. You will receive a detailed report at no obligation.



Finishing department operator at Landis Machine Co. gets ready for parts deburring run in Almco barrel finishing machine. Almco construction is heavy-duty throughout, to stand up under rugged requirements month after month.

SEND FOR THIS NEW BARREL FINISHING HANDBOOK

Complete description of the most advanced modern processes. 52 pages of facts, photos, data and cost comparison charts. Write for your personal copy today.

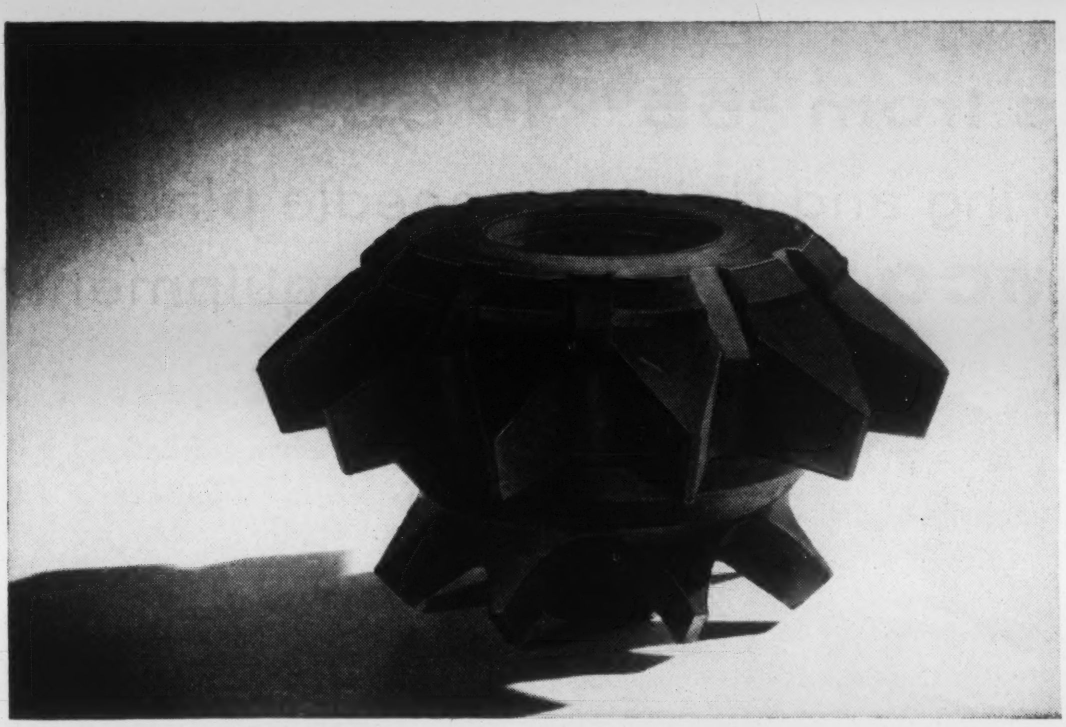


ALMCO

DIVISION OF QUEEN STOVE WORKS, INC.
35 Marshall Street • Albert Lea, Minnesota

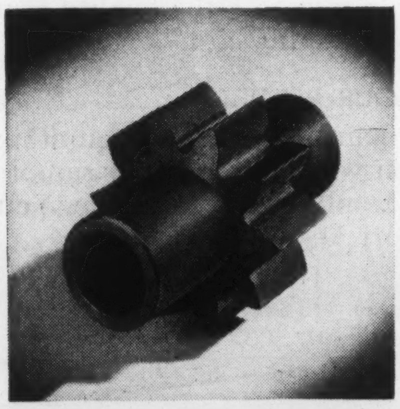
Sales Engineering Offices in Chicago, Detroit, Los Angeles, Newark, New Haven, Philadelphia and London, England.

For more information, turn to Reader Service Card, Circle No. 565

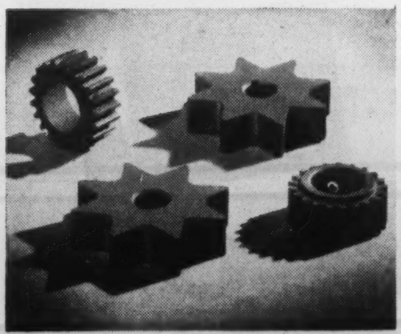


Oil well drill bit, carbide-surfaced by ASC, outlasts 5 untreated bits . . . cuts downtime 50% for oil exploration company.

The original stainless steel crimping roller showed definite signs of wear after processing 1 to 1½ million food cans. Identical rollers, ASC treated, processed 28 million food cans . . . showing no appreciable wear.



An ASC treated gear pump component outlasts 6 untreated units. In addition, its corrosion and heat resistance prevents contamination of the plastic material being processed.



Drive and spur gears, after ASC Metal Diffusion Treatment, have 3 to 4 times the wear resistance of untreated gears.

Atom Exchange

Creates Carbide Wear Surface On Steel Parts

Iron, steel and ferrous-base products which have to take the punishment of severe wear can now be given a treatment which vastly increases their resistance to wear and abrasion.

The new ASC Metal Diffusion Process produces a chromium-carbide surface on steel parts — medium and high carbon, regular, alloy or stainless.

The surface hardness, RC70-72, provides at least three times normal wear under the most difficult operating conditions . . . 10 to 30 times normal wear for many applications.

Even *stainless steel* can be vastly improved wearwise.

By *atom exchange* ASC Metal Diffusion Process produces a chromium surface which is an integral part of the parent metal. In addition to providing wear and abrasion resistance, this surface affords corrosion and heat resistance equal to 430 Stainless Steel.

Further information about this revolutionary process is yours for the asking. Write for additional data, consultation, or product demonstration.

ALLOY
SURFACES
COMPANY
103 South Justison Street, Wilmington 1, Delaware

For more information, turn to Reader Service Card, Circle No. 512

News OF INDUSTRY

T. Robert Burnight is director of engineering, Maico Co., Inc.

Orrin C. Bowers has been appointed chief engineer, BJ Electronics, a Borg-Warner facility.

E. G. de Coriolis was named "Engineer of the Year for 1957" by the Toledo Technical Council at the sixth annual engineers' week banquet.

Beecher B. Cary has been elected vice president of engineering and research, Standard Products Co.

Robert H. Caughey is now chief metallurgist, M. W. Kellogg Co., subsidiary of Pullman Inc., succeeding **Harry S. Blumberg** who is retiring to become a metallurgical consultant.

Lynn Chapman has been transferred to Danville, Ill. where he will assume the responsibility of supervising methods engineer, Hyster Co.

Joseph M. Culotta has been named chief product engineer for Pfaudler Co.

Marcel A. Cordovi is the recipient of the second annual Industrial Achievement Award presented by the N. Y. Chapter of the American Society of Metals.

Walter Donner has been appointed assistant director of research and engineering for laboratory instrumentation, Scientific Instruments Div., Beckman Instruments, Inc.

Adolphe J. De Matteo, former chief engineer, has been appointed general manager of Watson-Stillman Press Div., Farrel-Birmingham Co., Inc.

H. D. Emmert, Jr. succeeds **H. S. Bimpson,** retired, as chief engineer, Allis-Chalmers steam turbine dept.

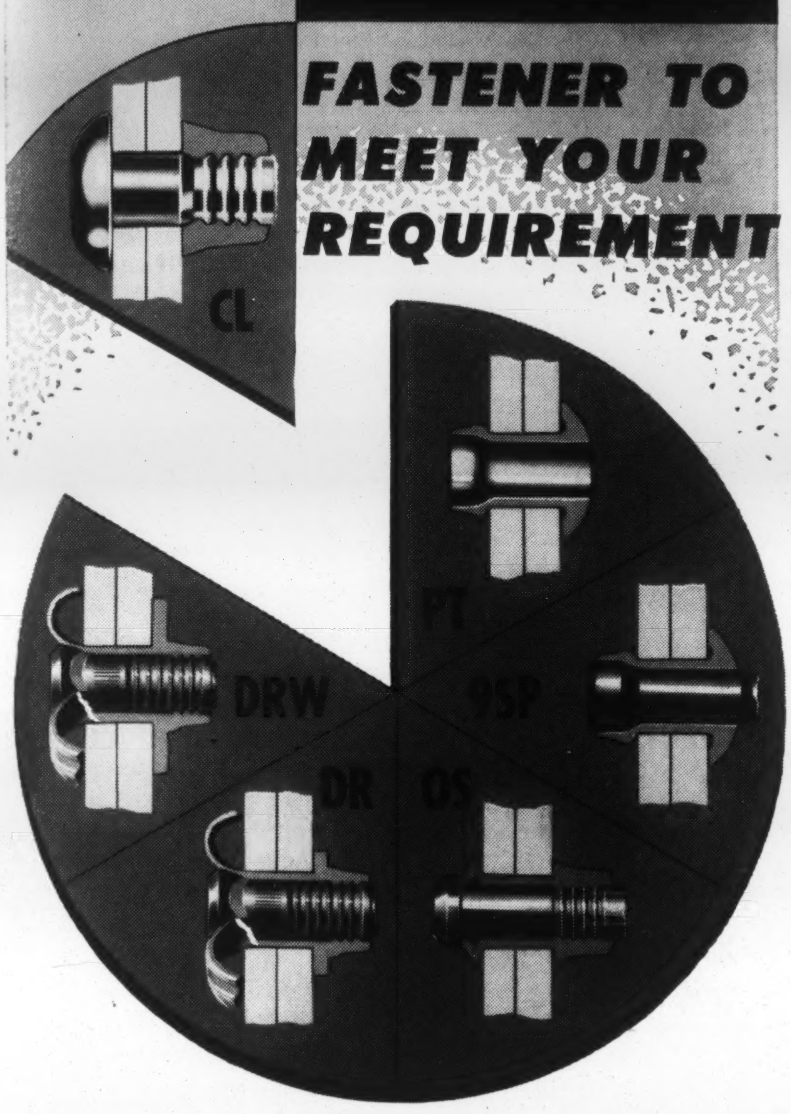
C. Donald Fisher, former chief engineer, has been named director of research and product development, Sprout, Waldron & Co., Inc.

T. J. Gillick, Jr., and **H. G. Hencken** have been named engineering and research manager and engineering director, respectively, American Felt Co.

Wayne L. Gasper is now assistant chief engineer of laboratory and

there's a **HUCK**

FASTENER TO MEET YOUR REQUIREMENT



Hundreds of manufacturers here and abroad have found the answer to their toughest fastening problems in HUCK'S complete line of commercial, positive-locking rivets.

Huck fasteners are available in many sizes and shapes to meet the many specialized requirements of industry, from railroads to electronic fabrication. Their fast, simple application and positive locking features save production dollars, time and trouble for their many users—producing a better fastening job.

Write or call for a HUCK sales engineer to discuss your problems. There's no obligation.

U.S. Patent numbers 2531048, 2531049, 2754703, 2527307 and patents applied for.

HUCK *MANUFACTURING COMPANY*

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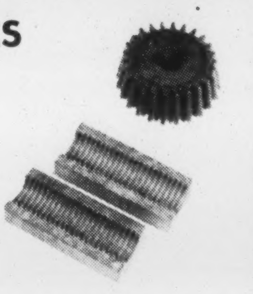
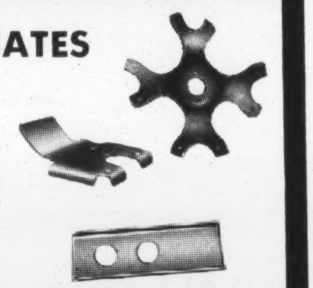


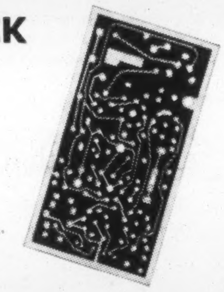
POST-FORMED LAMINATES

Post-forming produces lightweight parts of metal-like rigidity that are abrasion and weather-resistant, noncorrosive, and economical. Available in fabric or paper base stock 1/32" to 1/4" thick, in natural or black.

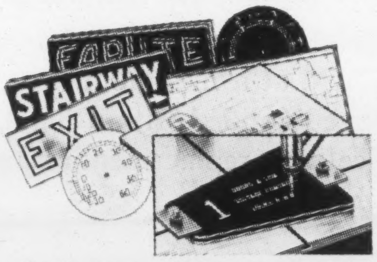


PRINTED CIRCUIT STOCK

Highest quality laminates ideally suited for making printed circuits where low water absorption, power factor, maximum insulation resistance, and surface sensitivity are needed. Meets or exceeds all NEMA requirements for classification XXXP.



ENGRAVING AND NAME PLATE STOCK



Designs engraved in this surface of Grade ES-70 expose sublayer of contrasting color. Ideal for signs, dials, etc.

Grade MF-60 also available for protecting printed graphs, charts, etc. with hard, scratch-free transparent surface.

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FREE CATALOG

PLASTICS DIVISION

FARLEY & LOETSCHER

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INDUSTRIAL LAMINATES • POST-FORMED LAMINATES • PRINTED CIRCUIT STOCK • ENGRAVING AND NAME PLATE STOCK • DECORATIVE LAMINATES

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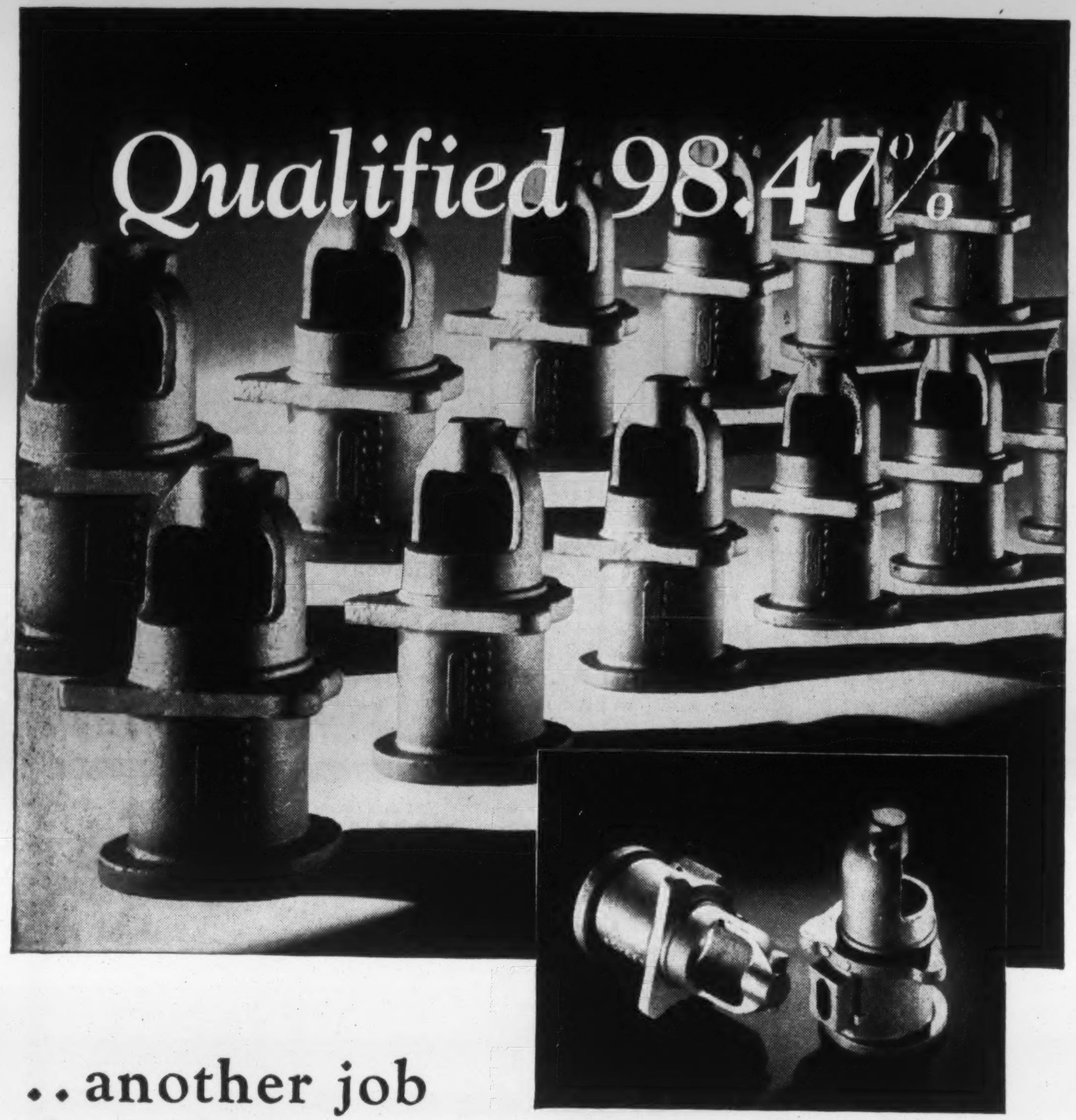


..another job done better with UNITCASTINGS!

Faced with a problem of economically producing a starter housing that would take more than normal abuse, Unitcast engineers successfully provided the answer with *steel* castings. Previous to the use of Unitcastings, replacement costs were excessive and the need of a tougher material was imperative. Cost was also an important requisite, and by delivering *consistent* quality in conjunction with a tougher material—scrap and lost time has been held at a minimum. To date, more than 33,000 units have qualified with a higher basic cost being offset by practically no replacement and most important—a lower *finished* cost!

Take another look at the *finished* cost of your parts inventory—perhaps you *can do better with Unitcastings!* Consult a Unitcast engineer, soon!

UNITCAST CORPORATION, Toledo 9, Ohio
In Canada: CANADIAN-UNITCAST STEEL, LTD., Sherbrooke, Quebec

Unitcast

QUALITY
STEEL
CASTINGS

For more information, turn to Reader Service Card, Circle No. 639

technical processes, a newly created position at Maytag Co.

William J. Goodwin, research engineer, has moved from Electro-Metallurgical Corp. to the crucible laboratory of Electro Refractories & Abrasives Corp.

Norman D. Groves has been chosen to direct the corrosion research laboratory, Carpenter Steel Co.

John C. Herrera and **Edwin Westbrook** have joined the staff of High Voltage Engineering Corp. as senior engineers.

Cyrus Hough has been appointed vice president in charge of engineering, Bellevue Industrial Furnace Co.

W. Fred Heine is now chief engineer, Mohawk Busines Machines Corp.

J. R. Hursh has been promoted to chief products engineer, Engineering Dept., Armco Drainage & Metal Products, Inc.

W. A. Hunter has joined the Beardsley & Piper Div., Pettibone Mulliken Corp., as project and development engineer.

George W. Hartwell has been appointed chief engineer, commercial refrigeration equipment, Worthington Corp.

Dr. John K. Hilliard is now director of advanced engineering, Altec Lansing Corp.

H. G. Johnstin, metallurgical engineer, will manage the new metallurgical product development group, Vanadium-Alloys Steel Co.

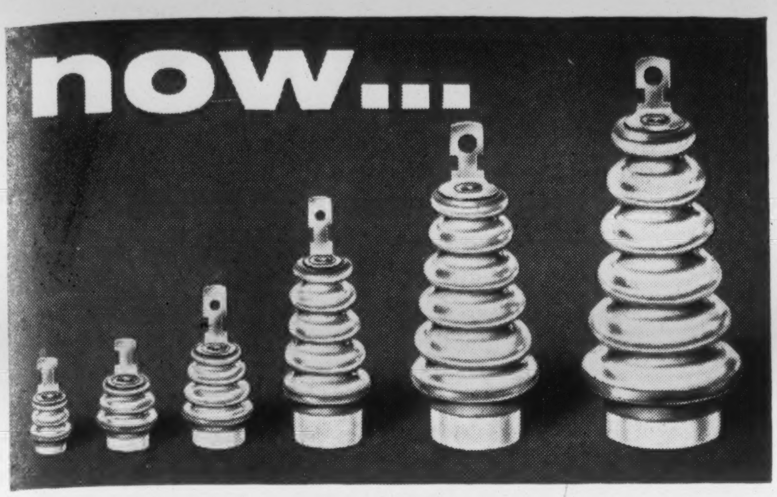
Eric A. Kolm has received the first Du Pont Nondestructive Testing Award for outstanding contribution to the field of nondestructive testing.

Dr. Gerald V. Kingsley replaces **W. E. McCullough, retired,** as director of research, Bohn Aluminum and Brass Corp.

Dr. Winston E. Kock, Dr. John D. Trimmer, Jay E. Browder and **William Hampton** have been appointed to key positions in the new Systems Div., Bendix Aviation Corp.

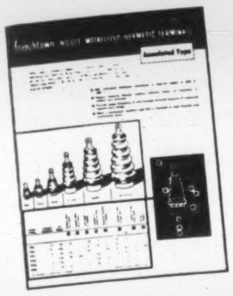
(news of Companies on p 214)

For more information, turn to Reader Service Card, Circle No. 387



Frenchtown Metallized Terminals!

Here is Frenchtown's improved line of Annuluted Type NICOTE Metallized Hermetic Terminals for use in controls, relays, transformers, capacitors, motors, and heater units. Custom-engineered of HIGH ALUMINA CERAMICS and metallized with our exclusive NICOTE, these terminals are available in six varying sizes with a choice of terminal hardware to fit any exacting application. Write for Engineering Bulletin 1055.



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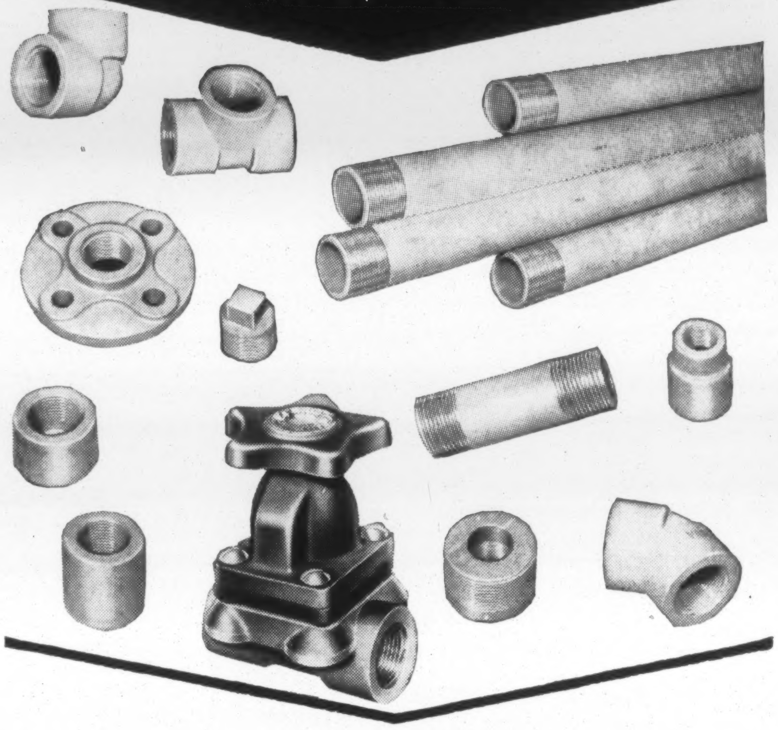
Corrosion with...

Van-Cor

PLASTIC PIPE, FITTINGS AND FABRICATIONS



★ *Both Chemical Resistant, Normal Impact, and Chemical Resistant, High Impact*

★ *Half the Weight of Aluminum, with High Tensile Strength*

★ *Readily Formed, Machined, Drawn, Molded or Welded*

AVAILABLE FORMS

PIPE—¼″ thru 12″ diameter (10 or 20 ft. lengths) . . . FITTINGS—¼″ thru 12″ . . . VALVES—½″ thru 2″ . . . SHEETS—1/32″ thru 2″ . . . ROUND BARS—¼″ thru 2″ diameter (10 ft. lengths) . . . WELDING ROD—⅛″ and 5/32″ diameter.

TYPICAL APPLICATIONS

A rigid unplasticized polyvinyl chloride, Van-Cor is fabricated into such products as: Ducts, Hoods, Chemical Tanks, Tank Liners, Plating Racks, Fume Stacks and Piping.

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INDUSTRIAL DIVISION OF
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SUBSIDIARY OF THE VAN DORN IRON WORKS CO.
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***Listed below are *SOME* of the highly recommended, leading new and standard Technical and Scientific reference books:**

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News OF INDUSTRY

Jack M. Kramer has been appointed project engineer, Flexible Tubing Corp.

Revis L. Stephenson is now executive vice-president of United States Hoffman Machinery Corp. He will continue as director of the Hoffman Foreign & Export Operations and superviser of the Industrial Divisions.

Henri Soumerai is chief engineer, Refrigeration Compressor Development, Air Conditioning & Refrigeration Div., Worthington Corp.

A. S. Thaeler has replaced **R. C. Stanbrook**, retired, as vice president-engineering of Pittsburgh Steamship Div., U. S. Steel Corp.

O. A. Wright has been appointed engineering manager of Actuation Research Corp.

John C. Wallace is Walworth Co.'s new vice-president of engineering.

J. F. Weiffenbach succeeds **Henry M. Haase** as director of research and engineering for Borg-Warner Corp. Mr. Haase is now president and chief executive officer of Borg-Warner's York Div.

Clinton Westin and **Jay Rakstis**, Superior Steel and Malleable Castings Co., have been promoted to assistant general manager and chief metallurgist, respectively.

Clifford E. Wenninger has been appointed Technical Director, Beardsley & Piper Div., Pettibone Mulliken Corp.

Companies

Harper Landell & Associates is the name of a new industrial design company. The entire staff of the late Harold Van Doren has been retained by the new company.

Parker Appliance Co. has purchased **Franklin C. Wolfe Co.** and **Mathewson Corp.** The Mathewson Corp. will be moved next to the Wolfe Co. and both will be operated as the Franklin C. Wolfe Co. Div. of Parker Appliance.

Narmco Mfg. Co. is building a 20,000-sq ft plant addition that will increase manufacturing capacity by more than 20%.

Pittsburgh Standard Conduit Co. will move its Etna operations to Verona in early 1958.

(continued on p 316)

STANWOOD SALT POTS
for maximum economy

Available in either cast or fabricated alloy construction. Flat or rolled flanges. Also one-piece pressed steel pots — plain and high temperature coated.

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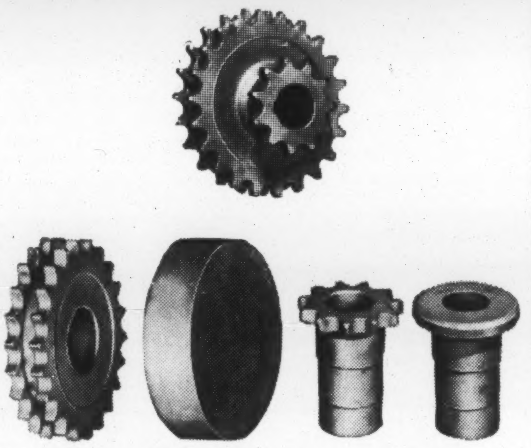
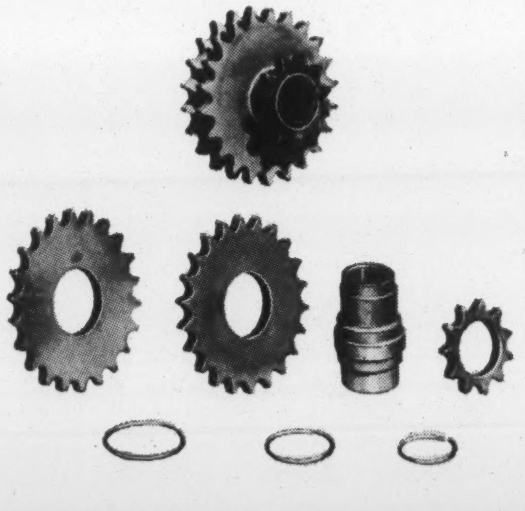
EASY FLO
SIL FOS

JOIN WITH HANDY & HARMAN SILVER BRAZING FOR PERMANENT PROFIT



⬆ Before, sprocket was machined and hobbed from solid metal, then welded. Now, three stampings are EASY-FLO-brazed to turned hub.

Result—sprocket made stronger in less time, with less metal. ⬇



Clever, these Design Engineers!

The cleverest designers of all are those who know that silver alloy brazing, specified as the joining method at the *design stage*, can be of great value. The benefits that go hand in hand with brazing—of cost, of time, of labor, of product superiority, warrant consideration from the start.

Examples of how design for brazing simplifies production and improves the product are numerous . . . to give you an idea of what can be saved through Handy & Harman silver alloy brazing with EASY-FLO 45, take a look at this:

Triple Sprocket for Self-Propelled Combine

Originally, double sprocket was bored, turned and hobbed from solid stock; small sprocket and hub were turned from single piece of bar stock. Large sprocket was then welded to hub as shown.

Redesigned for EASY-FLO brazing, large and small sprockets are blanked from 1/2" plate and bored and hobbed in groups; hub is turned from much smaller diameter bar stock. Three rings of 1/16" EASY-FLO wire join the entire assembly. All joints are Handy-Fluxed. Large sprockets and hub are jigged with one preplaced ring of EASY-FLO around hub above each sprocket and induction-brazed in 30 seconds. Third EASY-FLO ring brazes small sprocket to hub end in 17 seconds. Total: 47 seconds for completed assembly. Results: Lower over-all production costs due to savings in metal, machining and joining time. A stronger sprocket due to full-area penetration of the alloy.

This is just one example of the benefits enjoyed with one Handy & Harman alloy and brazing method. We'll be happy indeed to talk to you about all kinds of silver brazing alloys and their attendant benefits. We have found that if we join forces right at the start, the results are right . . . all the way. Just call us.

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- NEW ALUMINUM BRAZING ALLOY
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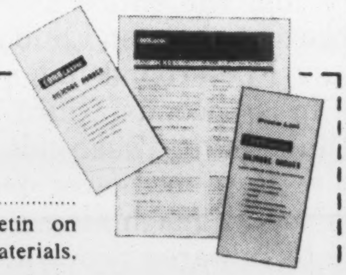
CHR Silicone Rubber NEWS

CHR has a new low durometer silicone rubber

Higher tear strength, lower compression set than any previous low durometer stock.

The new COHRlastic R-11568 with softness in the range of sponge is now available in custom sheets and moldings. This 25 durometer silicone rubber has high tensile, elongation and tear strength, unusually low compression set, −100° F to 480° F flexible temperature range.

Write for bulletin on CHR's soft sealing material which gives basic facts on new R-11568, compares it with silicone sponge rubber and silicone foam rubber (COHRfoam).



Send .... copies of bulletin on soft sealing materials.

☐ Include CHR Stock Item folder & price list.

☐ Include CHR Coated Fabric bulletin.

NAME

TITLE DEPT. OR CODE

COMPANY

STREET

CITY ZONE STATE

CHR THE CONNECTICUT HARD RUBBER CO.
409 East St., New Haven 9, Conn.

For more information, Circle No. 541

News OF INDUSTRY

Townsend Co. has acquired **G. O. Noville & Associates, Inc.** Noville will be operated as a wholly-owned subsidiary under the direction of Commander G. O. Noville.

Modern Mfg. Co., Inc. will open its new 10,000-sq ft Willow Grove plant June 1.

Parker Aircraft Co. will complete its expansion of engineering facilities by July 1.

Loftus Engineering Corp. has moved its business offices to One Gateway Center, Pittsburgh 22.

Firestone Tire & Rubber Co.'s four new plants, located at Orange, Texas, Havana, Cuba, Noblesville, Indiana, and Manila, Philippine Islands, are scheduled for completion by October.

American Can Co. has begun installation, at its St. Louis plant, of new facilities for processing coiled steelplate. Plans call for eventual installation of similar equipment at its other plants.

El-Tronics has purchased **Warren Plastics Corp.** and its subsidiary, **Cropp Engineering Div.** Both companies will be operated as wholly-owned subsidiaries.

Atlas Corp. has acquired a controlling interest in **Reo De Oro Uranium Mines, Inc.**

Graham, Savage & Associates, Inc. is the new name of Graham, Crowley & Associates, Inc.

Servionics, Inc. W. Hempstead, L. I., is a new engineering and design corporation.

Vaculloy Corp., Wooster, Ohio, is a new firm in the vacuum melting field.

Trojan Metal Products is the new name of **Auto Sheet Metal Works.**

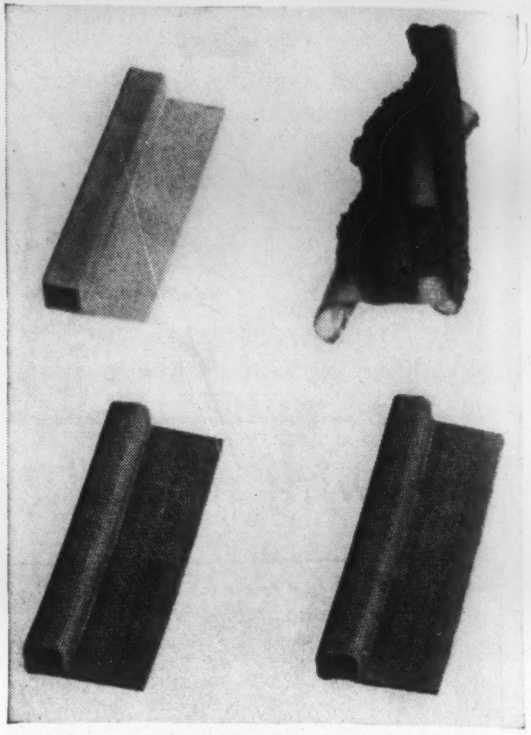
Microdot Inc. has moved to new quarters in S. Pasadena.

Haller, Raymond and Brown, Inc. has begun construction of a three-story building which will house management and research facilities.

Haskelite Mfg. Corp. is the new name of **Evco, Inc.,** a subsidiary of Evans Products Co.

(continued on p 318)

CHR Silicone Rubber NEWS



At left, control samples; at right, seals soaked 16 hours in AN-F-48 (100/130 octane) fuel. Seal made with ordinary silicone rubber (top right) is destroyed. Seal made with new Dow-Corning LS-53 (bottom right) is virtually unaffected and is tough, resilient and operable.

NEW . . . CHR fuel resistant silicone rubber SEALS

Resist jet fuels, hydraulic and synthetic oils, and abrasion in temperatures —85°F to 400°F.

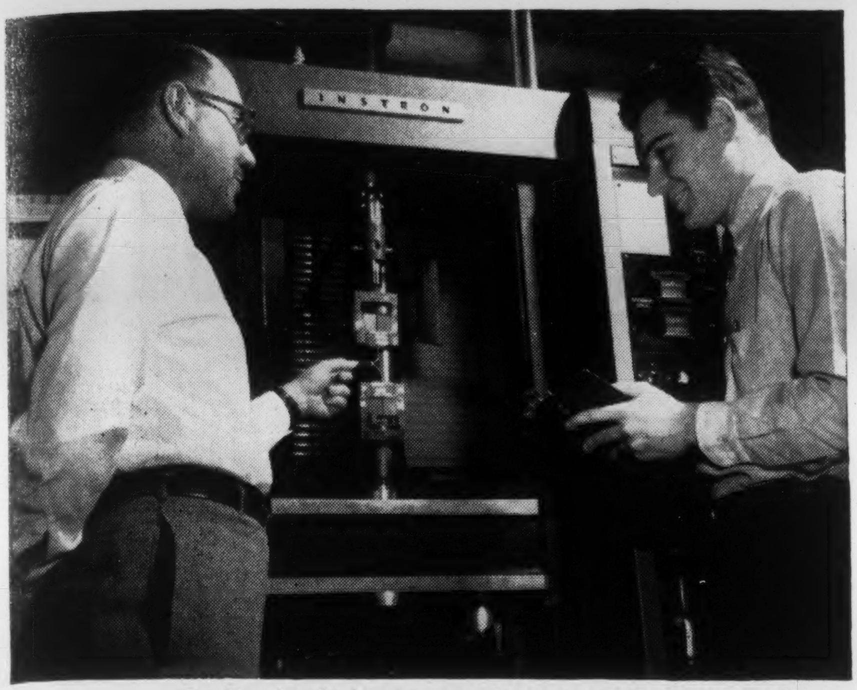
The new Dow-Corning LS-53 is the first rubber to combine fuel resistance with extreme high and low temperature flexibility. This *fluoro-silicone* rubber can be sponged, molded, extruded. It is readily adaptable to seal constructions which provide the most practical and economical use of the rubber.

LS-53 is available *now* and CHR is already designing it into fabric reinforced seal constructions. The outstanding resistance of these seals to one aircraft fuel is illustrated *above. Write or phone* for a CHR data sheet giving full test data. If your need for LS-53 seals is immediate, CHR will expedite seal design coordination and production. Phone or write us. CHR field representatives are available for direct contact.

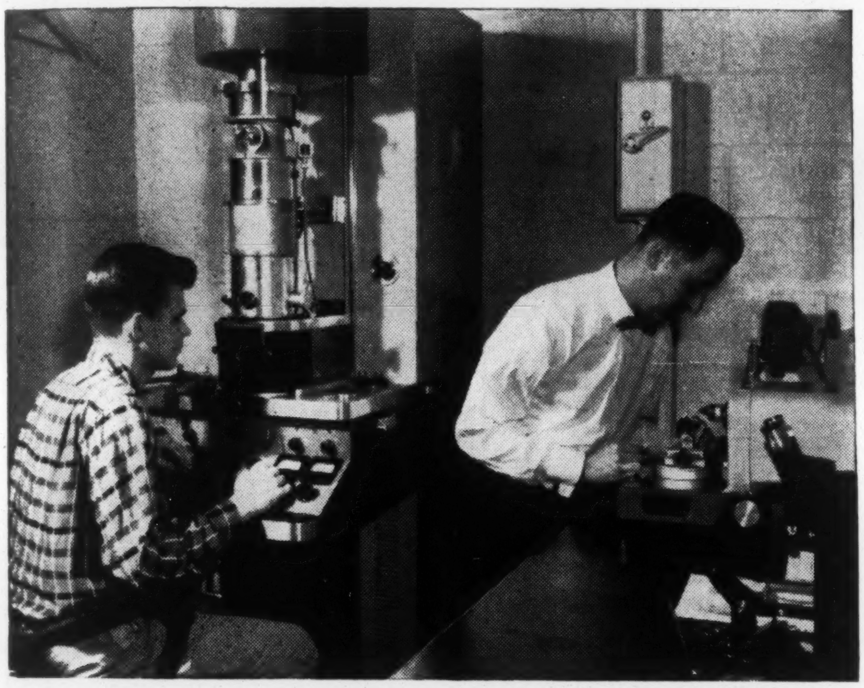
ALSO AVAILABLE, LS-53 custom molded sheets, extrusions, sponge sheets, sponge extrusions, COATED FABRICS.

CHR THE CONNECTICUT HARD RUBBER CO.
409 East St., New Haven 9, Conn.

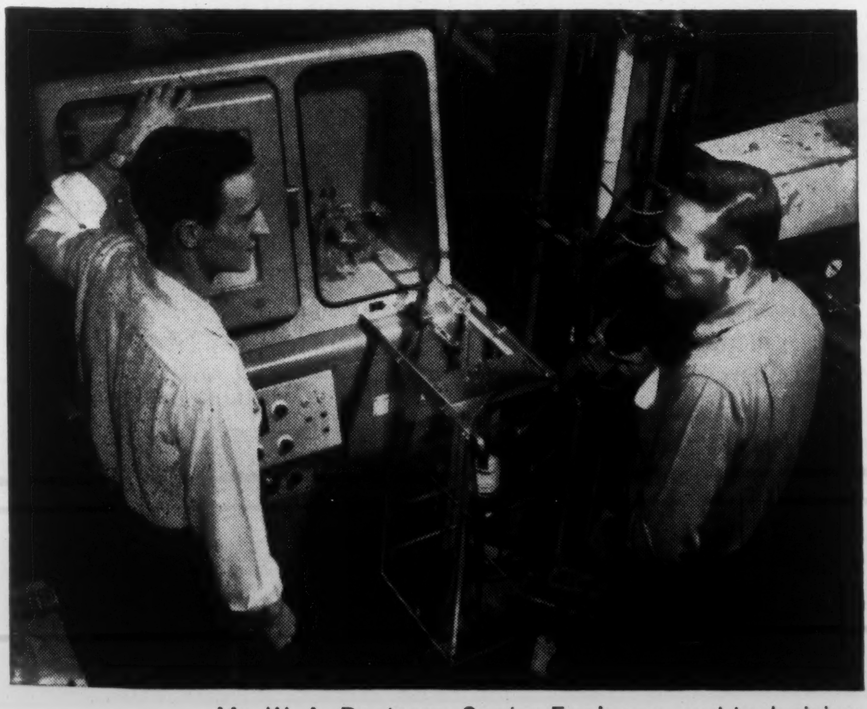
For more information, Circle No. 542



Dr. Benjamin Lustman, Manager of Pressurized Water Reactor Metallurgy, and technician K. Marsh are testing the mechanical properties of zirconium brazing alloys.



Dr. M. W. Burkart, Fellow Engineer, and Mr. P. Schnizler, technician, are examining the fracture surfaces of UO_2.



Mr. W. A. Bostrom, Senior Engineer, and technician W. Bowen measure gas transport in metals using mass spectrometric analysis.

METALLURGISTS

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If you are interested in exceptional career opportunities, the expanding nuclear power industry offers you a creative challenge.

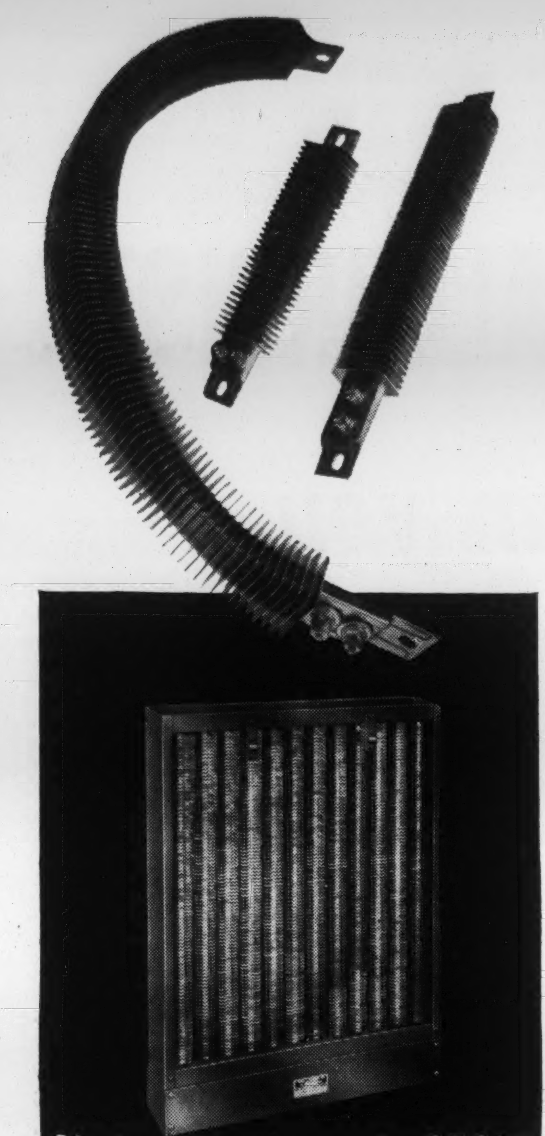
Metallurgists engaged in alloy development work are pictured in well-equipped Westinghouse Bettis Plant laboratories. They are performing tests which involve kinetics and mechanisms of corrosion and oxidation, mechanical properties, and solid state transformations. A few other examples of work, not shown, include x-ray diffraction analysis, physical chemistry of molten metals, phase diagram determination, and irradiation effects in metals. These represent some of the experiments necessary to develop the materials for fuel elements and vessel structure which will be used for nuclear reactors and cores. Designed and developed by Bettis scientists and engineers, these reactors will power nuclear submarines and surface ships as well as the nation's first full-scale commercial nuclear power station.

We welcome inquiries from metallurgists who are interested in joining outstanding scientists for a career in nuclear power. Please address resumes to: Mr. M. J. Downey, Dept. A-158, P.O. Box 1468, Pittsburgh 30, Pennsylvania.

BETTIS PLANT

Westinghouse

For more information, turn to Reader Service Card, Circle No. 397



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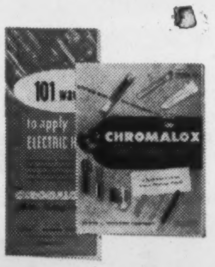

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CHROMALOX FIRST NAME IN ELECTRIC HEAT

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News OF INDUSTRY

Branson Instruments, Inc., and its subsidiary Branson Ultrasonic Corp., have moved into a new 24,000-sq ft plant.

D. E. Makepeace Co. has broken ground for a new 53,000 sq ft plant to supplement existing facilities.

Bettinger Corp. has acquired complete ownership of the **Porcelain Enamel Products Co. PEPCO is now** operated as a Division of Bettinger.

Parker Appliance Co. has purchased **The Franklin C. Wolfe Co., Inc.** and the **Mathewson Corp.** Both companies will be located in Culver City and operated as the Franklin C. Wolfe Co., Div. of Parker Appliance.

Fansteel Metallurgical Corp. has authorized an expenditure of $665,500 for new constructions at their north and south plants.

Quick Industries, Inc. has formed a new division, Quick Plastics.

Omer E. Robbins Co. has constructed a new 10,000 sq ft building next to its old plant for additional manufacturing and office space.

Mine Safety Appliances Co. has purchased **Protection, Inc.** The absorbed company will be operated as an autonomous division in new quarters in Los Angeles.

Berkeley Div., Beckman Instruments, Inc., announces a $1,500,000 expansion program that will triple production capacity. Completion of the project is expected early next year.

Lancaster Lens Co. has acquired controlling interest in Indiana Glass Co.

Sullivan Powdered Metals, Inc. has formed a new division devoted exclusively to the development and application of special blends of aluminum pastes and powders for use as pigments in plastics, paper coatings, printing inks and fabric finishes.

Bell Aircraft Corp. has acquired **Lake Erie Engineering Corp.** The latter will be operated independently as a wholly-owned Bell subsidiary.

Durable Formed Products, Inc., Regal Plastic Co. and **Speck Plastics, Inc.** have entered into a "working agree-

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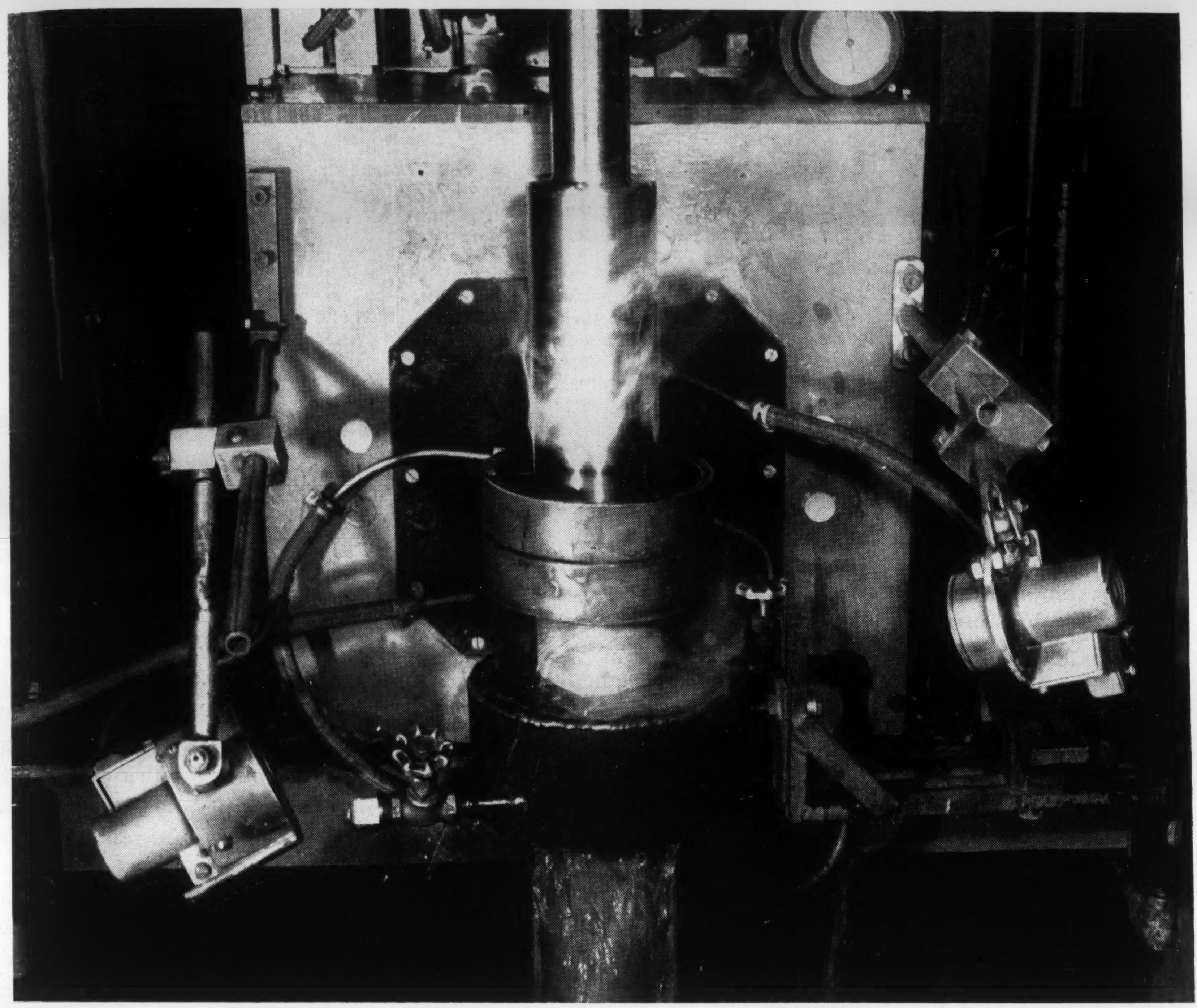
For more information, Circle No. 450



Soaking up heat radiation...

. . . these two L&N Rayotube® detectors are helping McKay Machine Company induction-harden bodies of leveller rolls. About four years ago, this manufacturer of sheet, tin and strip mill equipment switched to full time induction hardening of these shafts which range from 7/8″ to 12″ in diameter and up to 12′ long. The new method doubled production . . . eliminated warpage . . . and provided scale-free hardening. And, in addition, the use of L&N temperature control enabled the McKay Machine Co. to reduce setup time . . . eliminate trial runs . . . and produce the same results heat after heat.

The temperature regulating equipment consists of Speedomax®-Rayotube control on each of two 3000-cycle induction generators having a maximum capacity of 400 kw. One Speedomax in combination with a Rayotube detector controls work temperature by operating a motor-operated rheostat to regulate power input to the induction coil. For quality control, a second Speedomax-Rayotube combination measures and records quench temperature while a third Speedomax provides a record of work speed through the coil.

To find out how L&N temperature control may help increase the efficiency of your induction heating, contact your nearest L&N sales office or write 4925 Stenton Ave., Phila. 44, Pa.

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- **maximum uniformity of size for the sintered products.**
- **maximum pounds of quality product per dollar of investment.**

We have built many sizes and types of furnaces for processing a wide variety of ferrous and non-ferrous metal powder products—also continuous equipment for bonding metal powders to strip and for other processes.

Long experience with special atmospheres, metal powders and all heat processing phases in connection with powder metallurgy has enabled EF engineers to develop and install special atmosphere equipment for producing some rather outstanding results.

With our extensive experience and complete manufacturing facilities we are in position to build the best size and type to fit your specific requirements.

We would like to discuss some of our latest furnace developments with you, if interested.

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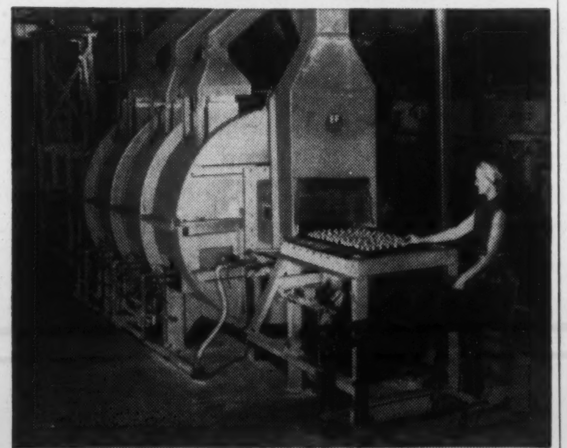
We Build Gas Fired, Oil Fired and Electric Furnaces—For Any Process, Product or Production.


EF gas fired muffle type continuous furnace, another of the various types we build for sintering non-ferrous and iron powder prducts at temperatures up to 2050° F.

Canadian Associates:
CANEFCO LIMITED • Toronto 1, Canada

ment" to coordinate their plastics engineering efforts.

Ferro Corp. has consolidated its ceramic research facilities into the Ferro Ceramic Technical Center.

Swedlow Plastics Co. has acquired controlling interest of **Honeycomb Structures Co., Inc.**

United Aircraft Products, Inc. plans a $1-million expansion program which includes purchase of a new plant.

AMP Inc. is now the official name of **Aircraft-Marine Products, Inc.**

Minnesota Mining & Mfg. Co. has purchased **M. W. Kellogg's** Kel-F manufacturing facilities.

Societies

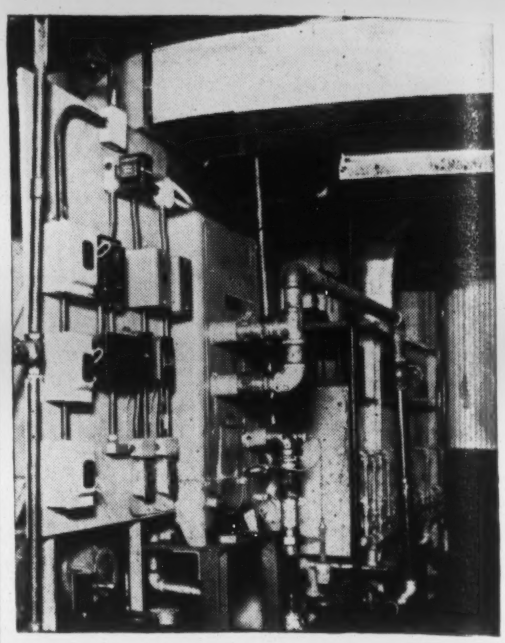
Society of Women Engineers presented its 1957 award for significant contribution to engineering to Rebecca H. Sparling, design specialist, General Dynamics Corp.

National Assn. of Corrosion Engineers has elected the following officers: W. H. Stewart — president, Sun Pipe Line Co.; L. L. Whiteneck —vice-president, Plicoflex, Inc.; A. L. Stegner—treasurer, Tennessee Gas Transmission Co. Directors are: E. G. Brink, American Viscose Corp.; E. E. Kuster, Union Gas Co. of Canada, Ltd.; R. S. Treseder, Shell Development Co.; F. E. Costanzo, Manufacturers Light and Heat Co.; John B. West, Aluminum Co. of America.

National Electrical Manufacturers Assn. has formed a special committee to publicize new developments in the semiconductor field.

National Screw Machine Products Assn. has admitted the following companies and their representatives: Airport Industries, Inc.—J. L. Miller; Beamco, Inc.—H. W. Branigar, Jr.; Commercial Tool Works, Inc.—E. J. Kepler; Conn. Mfg. Co.—J. R. Curtis; Rosemoor Mfg. Co.—R. A. Staat; L. S. P. Inc.—H. T. Van Dalsen.

American Lithium Institute is sponsoring research programs on lithium



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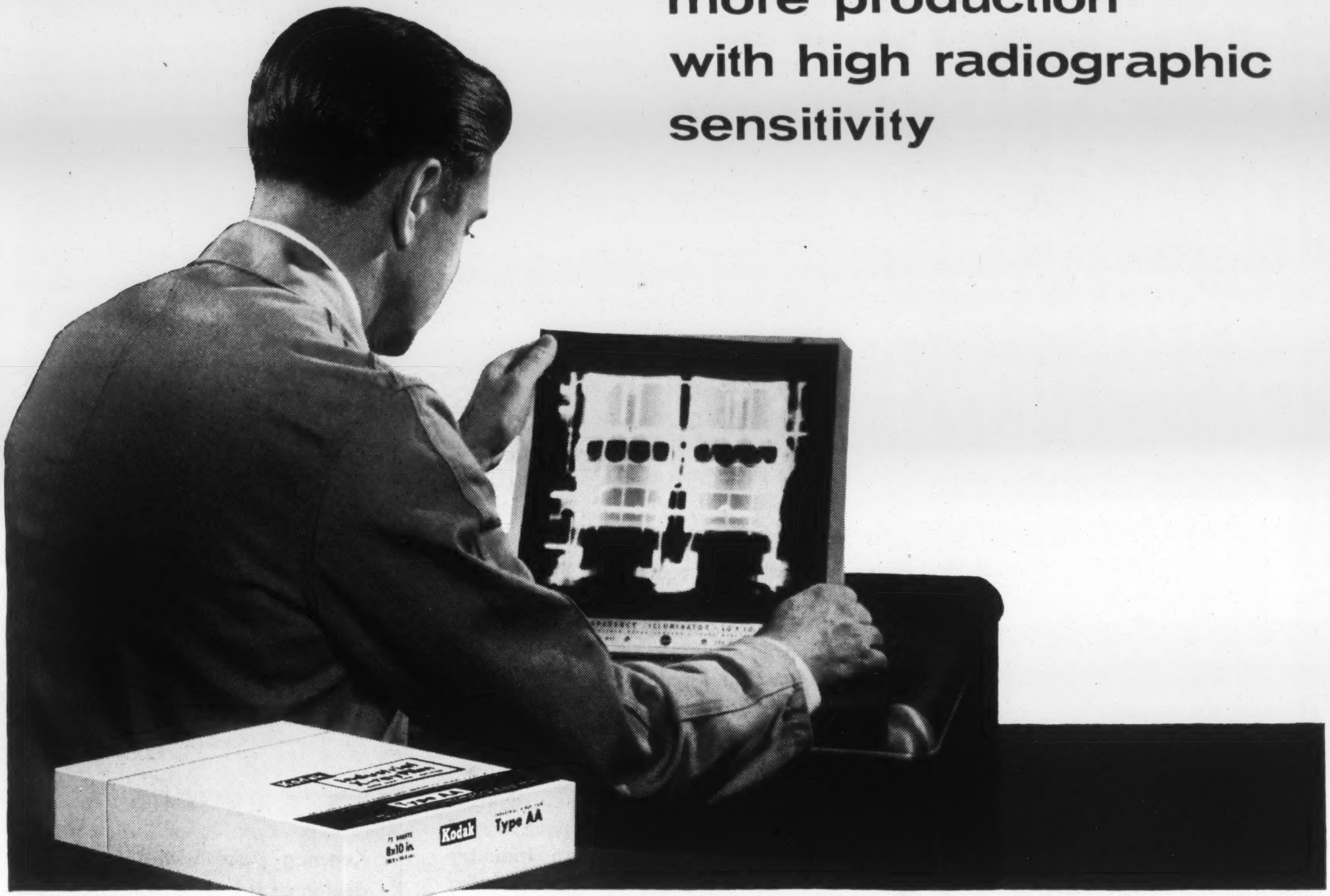

KODAK INDUSTRIAL X-RAY FILM, TYPE AA

Whatever source of radiation you use, you'll get more high-quality work done—faster—with Kodak Industrial X-ray Film, Type AA.

For Type AA has greatly increased speed—as much as twice as fast with gamma rays and high kv x-rays. It permits inspection of thicker parts, slashes exposure time, increases production and extends the usefulness of existing radiographic equipment.

And with all this increased speed the new film equals the fine radiographic sensitivity characteristics which made Kodak Type A the most widely used x-ray film in the industry.

Kodak Industrial X-ray Film Type AA can save you time; provide clear, easier-to-read radiographs; and help turn out more work. Get all the details—either from your Kodak x-ray dealer or the Kodak Technical Representative.

Read what the new Kodak Industrial X-ray Film, Type AA, will do for you.

- Reduces exposure time—speeds up routine examinations.
- Provides increased radiographic sensitivity through higher densities with established exposure and processing technics.
- Gives greater subject contrast, more detail and easier readability when established exposure times are used with reduced kilovoltage.
- Shortens processing cycle with existing exposure technics.
- Reduces the possibility of pressure desensitization under shop conditions of use.

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ANCHOR PLASTICS EXTRUSION NEWS

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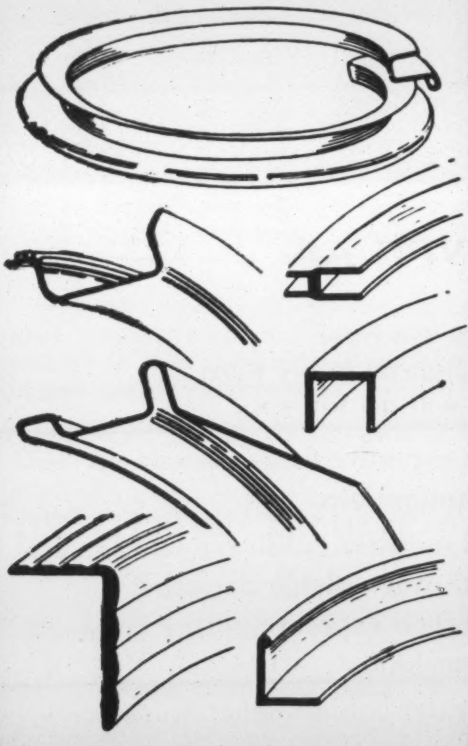

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For more information, Circle No. 516

News OF INDUSTRY

alloys, at Massachusetts Institute of Technology, and lithium-containing glass, at Pennsylvania State University. Fellowships will also be established by the institute.

Investment Casting Institute has admitted five companies and their representatives to membership: L. Sonneborn Sons, Inc.—Henry Levkoff; Gray Syracuse, Inc.—R. E. Gray; Hitchiner Mfg. Co., Inc.—J. H. Morison; F-R Machine Works—S. Brotman; Electronicast Div., Nilsen Mfg. Co.—P. A. Nilsen.

American Power Conference presented its Certificate of Merit to Dr. Walter H. Zinn for his contributions in the fields of nuclear power generation and atomic research. This is the second time the certificate has been awarded in the conference's 19-year history.

Vacuum Metallizing Assn. may become the name of an organization now forming for the purpose of: 1) creating standards on an industry wide basis; 2) establishing business ethics for the metallizing industry; 3) publicizing vacuum metallizing. T. J. LaBounty is chairman until permanent officers are elected.

Standards Engineers Society has elected the following 1957 officers: president H. G. Arlt, Bell Telephone Laboratories; vice president, F. E. Powell, Dept. of the Army; secretary, J. A. Caffiaux, Radio-Electronics-Television Manufacturers Assn.; treasurer, C. J. Lawson, International Business Machines Corp.; director-at-large, W. E. Aksomitas, Pratt and Whitney Aircraft Co.

Society of Plastics Engineers has announced these newly elected officers: president, Peter Simmons, Dow Chemical Co.; vice president, Haiman Nathan, Atlas Plastics, Inc.; secretary, R. K. Gossett, Gossett and Hill; treasurer, Jules W. Lindau, III, Southern Plastics Co.

American Institute of Mining, Metallurgical and Petroleum Engineers has reorganized its structure to transform its three branches into the Metallurgical Society of AIME, the Society of Mining Engineers of AIME and the Society of Petroleum Engineers of AIME.

(news of Meetings on p 324)

Somers THIN STRIP

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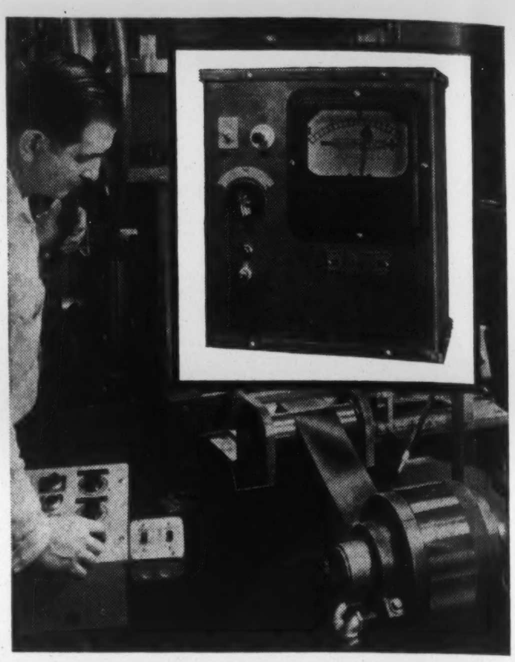
THIN



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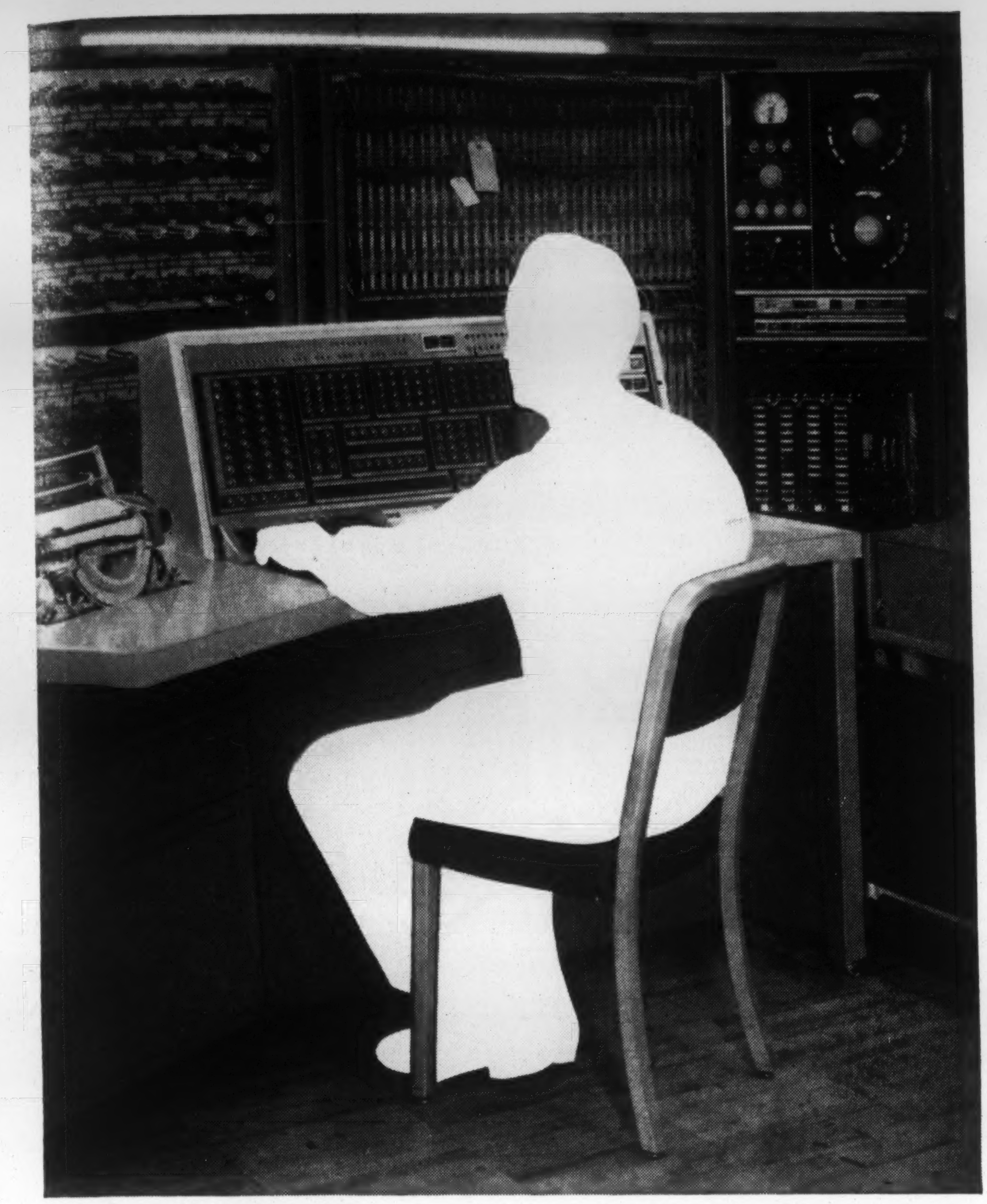

IBM growth promoted this man

Computer Programmer: Before his recent promotion, this man was a research programmer working with a giant IBM 704 electronic computer. He was engaged in the preparation of research problems of an engineering, scientific, business, and industrial nature for machine solution. His work entailed advanced diagnostic and application program development, including the modification of existing systems and proposed new systems. "This work has the same fascination as a game of chess," he'll tell you, "and the variety of constant challenges makes it absolutely absorbing!"

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- Test equipment design

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For more information, Circle No. 372

News OF INDUSTRY

Meetings

COPPER & BRASS RESEARCH ASSN., annual meeting. Hot Springs, Va. May 12-15.

ELECTROCHEMICAL SOCIETY, INC., spring meeting. Washington, D. C. May 12-16.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, design engineering conference. New York. May 20-22.

DESIGN ENGINEERING SHOW. New York Coliseum, New York. May 20-23.

AMERICAN IRON AND STEEL INSTITUTE, 65th general meeting of members. New York. May 22-23.

AMERICAN SOCIETY FOR QUALITY CONTROL, 11th annual convention, Detroit. May 22-24.

SOCIETY OF AUTOMOTIVE ENGINEERS, summer meeting. Atlantic City. June 2-7.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, semi-annual meeting. San Francisco. June 9-13.

MAGNESIUM ASSN., annual meeting. Hot Springs, Va. June 13-14.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting. Atlantic City. June 16-21.

AMERICAN ELECTROPLATERS' SOCIETY, annual convention, Montreal, Canada. June 17-20.

AMERICAN SOCIETY FOR ENGINEERING EDUCATION, annual meeting. Cornell Univ., Ithaca, N. Y. June 17-21.

ALLOY CASTING INSTITUTE, annual meeting. Hot Springs, Va. June 23-25.

AMERICAN SOCIETY OF HEATING AND AIR CONDITIONING ENGINEERS, semi-annual meeting. Murray Bay, Quebec, Canada. June 24-26.

SOCIETY OF AUTOMOTIVE ENGINEERS, West Coast meeting. Seattle. Aug 12-14.

WESTERN ELECTRONIC SHOW AND CONVENTION, San Francisco. Aug 20-23.

SOCIETY OF AUTOMOTIVE ENGINEERS, tractor meeting & production forum. Milwaukee. Sept 9-12.

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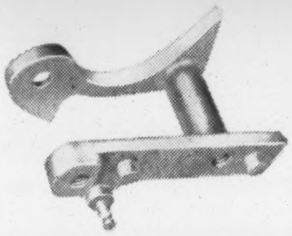
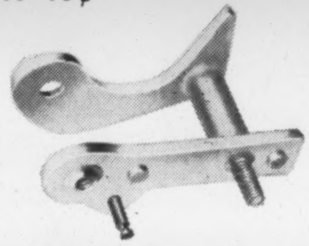
SWITCH FROM INVESTMENT CASTING TO STAMPED ASSEMBLY SAVES 71%

Short-Run Blanking Dies Cut Unit Cost from $1.48 to 43¢



Investment Casting Cost:
$1.48 EACH IN 1000 LOTS



Complete Stamped Assembly Cost:
43¢ EACH IN 1000 LOTS

An investment casting was formerly used involving additional machining operations. Converting to a brass stamped assembly gave the customer a more accurate, physically superior part at a 71% saving.

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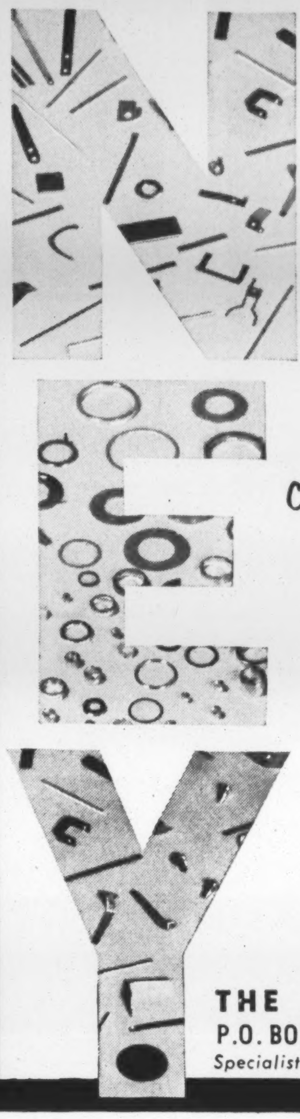
NEY'S SMALL PARTS PLAY A BIG PART IN PRECISION INSTRUMENTS



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- Turned
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- High thermal shock resistance
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For more information, Circle No. 389

BOOKS & REPORTS

Books

Bearing Design and Application. *Donald F. Wilcock and E. Richard Booser. McGraw-Hill Book Co., New York, 1957. Cloth, 6 by 9 in., 470 pp. Price $12.50.*

This book provides practical guidance to the machine designer in selecting and designing roller, thrust, and journal bearings for machinery. It should be of value also to personnel in metalworking and manufacturing industries.

The subject of bearing design and application is considered from three aspects: design of the bearing, including its geometry, general configuration and tolerances; materials from which the working parts of the bearing are made; and lubricants which serve to minimize friction and wear in the bearing.

Inventors and Inventions. *C. D. Tuska. McGraw-Hill Book Co., New York, 1957. Cloth, 6 by 9 in., 184 pp. Price $3.75.*

Briefly describes the history of invention and the effect of environment, education and age in scientific creativity. Invention and discovery are explored on a case-history plan, showing examples of inventions that are the outcome of experiments, happy accidents, direct approaches and scientific curiosity. Chapters on patentable inventions and marketing inventions present practical guidance to those who need it.

Symposium on Properties, Tests, and Performance of Electrodeposited Metallic Coatings. *American Society for Testing Materials, Philadelphia, 1957. Paper, 6 by 9 in., 129 pp. Price $3.*

Of interest to both producers and consumers of electroplated materials, this volume contains the following significant papers: corrosion behavior and protective value of copper-nickel-chromium and nickel-chromium coatings on steel; evaluation of methods available for measurement of surface luster of electroplated coatings; comparison of the corrosion behavior and protective

STRAITS TIN REPORT

MALAYAN TIN BUREAU

New developments in the production, marketing and uses of tin

Malaya's tin industry is now in a stronger position than that of any other country. Although there has been a decrease in the output of the European-managed dredges, the production of Chinese gravel pump mines has increased in compensation. Malaya's total production of tin-in-concentrates in 1956 was the best for any postwar year —62,295 long tons.

★ ★ ★

The Government of the State of Selangor in the Federation of Malaya recently decided to permit the development of a rich new tin-mining area of about 10,000 acres in the Kuala Selangor district.

★ ★ ★

Tin and tin-zinc solders are most commonly used in the electrical industry for small aluminum-copper connections. Tin-zinc base solders are also finding favorable acceptance for heater cores and engine radiators.

★ ★ ★

A weldable high-strength ternary alloy (92½% titanium, 5% aluminum, 2½% tin), which has become commercially available in sheets, plates, bars and billets, is finding widening use in aircraft manufacture, especially in jet engines and air-frames.

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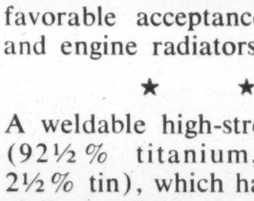
In recent tests by the Tin Research Institute two organotin compounds, triethyltin hydroxide and tributyltin acetate, showed great promise in preserving manila and sisal ropes immersed in seawater. Organotin compounds are already being used by industry for stabilizing PVC plastics and chlorinated rubber paints, preventing decomposition of synthetic chlorinated insulating oils, treatment of worms and larvae in poultry and cattle, preventing mould growth on decorators' paints, and slime control in paper manufacture. That's quite a list, and it's still growing steadily.



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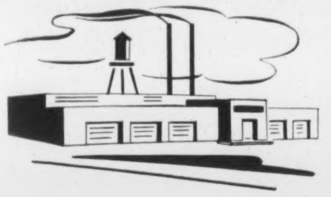

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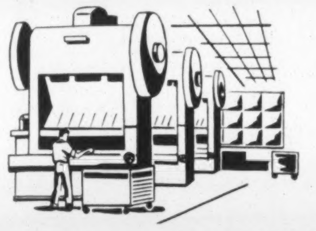

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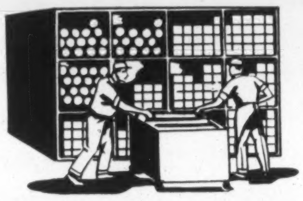

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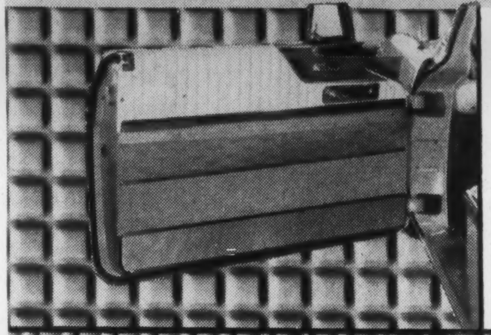

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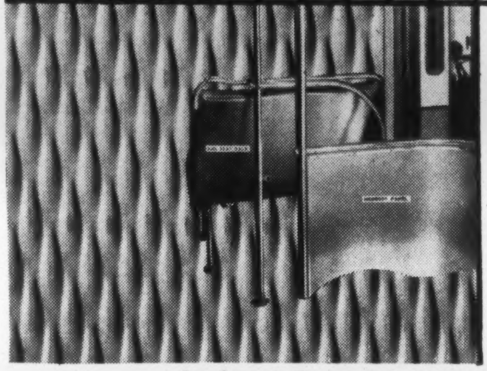

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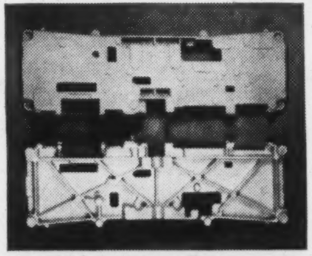

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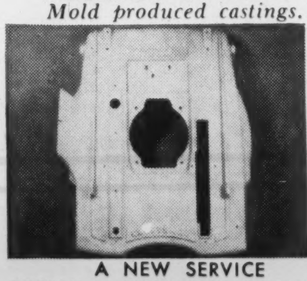

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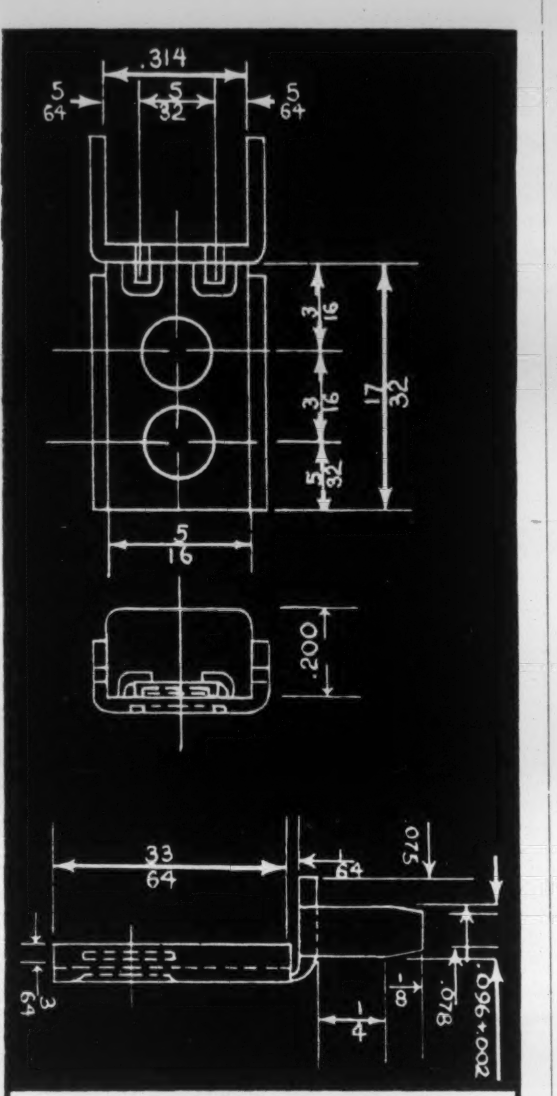

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value of electrodeposited zinc and cadmium coatings on steel; evaluation of phosphate coating over electrodeposited zinc; and a discussion of the standard salt spray test.

Statistical Methods in Quality Control. *Dudley J. Cowden. Prentice-Hall, Inc. New York, 1956. Cloth, 6 by 9 in., 751 pp. Price $12.*

The first twelve chapters of this book deal mainly with statistical methods in quality control and explain the relationships between probability, statistics and quality control. Other chapters deal with process and product control; use of control charts for variables during production; comparison of process control plans; economics of control charts; and single, double and multiple sequential sampling plans.

Graphics for Engineers. *Warren J. Luzadder. Prentice-Hall, Inc., New York, 1957. Cloth, 6 by 9 in., 600 pp. Price $8.65.*

Designed as a textbook for engineering students, this book discusses the art of making engineering drawings and using them as graphical representations to solve machine and other product design problems.

Emphasis is placed upon engineering geometry, multiview representation, basic descriptive geometry, and freehand sketching, with particular attention being given to perspective pictorials and graphical methods for solving engineering problems.

Modern Pulp and Paper Making: 3rd Edition. *John B. Calkin, Reinhold Publishing Corp., New York, 1957. Cloth, 6 by 9 in., 556 pp. Price $10.*

Although the subject matter of this book is concerned primarily with the principles of modern pulp and paper making, three chapters contain information on various types of paper and paperboard, on testing paper and paper materials, and on paper defects.

Reports

Resistors RESEARCH AND DEVELOPMENT OF CHROMIUM AND CHROMIUM ALLOYS FOR NEW FILM-TYPE RESISTANCE ELEMENTS. *E. R. Olson and others, Battelle Memorial Institute. Mar 1956. 60 pp. Available from Office of Technical Services, Dept. of Commerce, Wash 25, D.C. $1.50 (PB 121388)*

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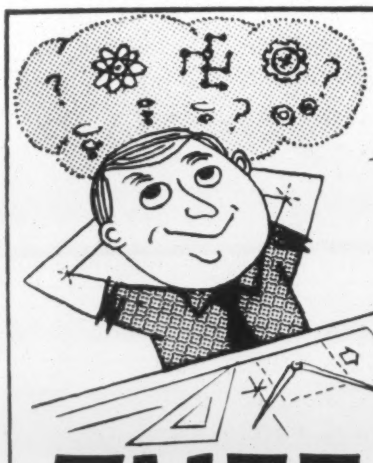

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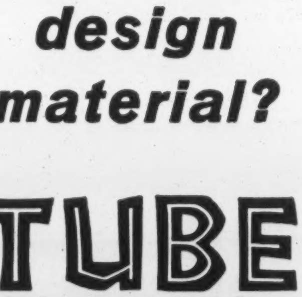

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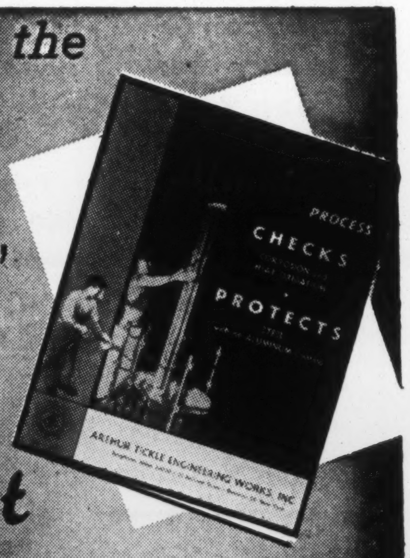

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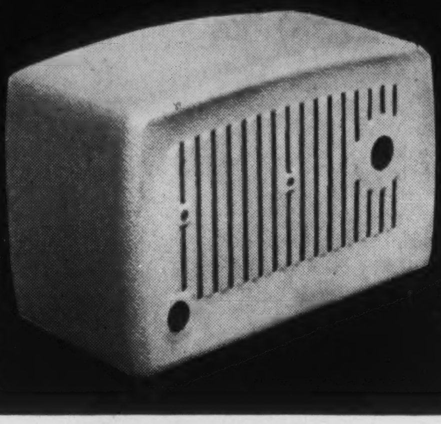

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and properties of chromium titanium-nitride and chromium-nitride resistors for high temperature applications. Complete engineering data for production refinement and development up to the prepilot-plant stage are given for chromium-titanium-nitride resistors. These resistors cover a resistance range of 100 ohms to 500,000 ohms. Poor reproducibility of electrical characteristics made necessary further work on development of chromium nitride resistors for production.

Permanent magnets BISMANOL PERMANENT MAGNETS, EVALUATION AND PROCESSING. *E. Adams and W. M. Hubbard, Naval Ordnance Lab. Jan 1953. 19 pp. Available from Office of Technical Services, Dept. of Commerce, Wash. 25, D.C. 50¢ (PB121278)*

Evaluates bismanol permanent magnets under various operating conditions. Improved fabrication techniques and equipment are described and methods of determining percentage of purity, alignment, and effective particle size in the magnets are discussed. The report recommends bismanol magnets up to 2-in. in diameter for applications requiring high magnetic flux density, such as in loudspeakers.

Low alloy steels SURVEY OF LOW ALLOY AIRCRAFT STEELS HEAT TREATED TO HIGH STRENGTH LEVELS: PART 3—FAILURE CAUSES. *G. Sachs, Syracuse University. July 1954. 80 pp. Available from Office of Technical Services, Dept. of Commerce, Wash. 25, D. C. $2 (PB 121667)*

Describes a number of failures in high strength steel aircraft parts from such factors as fatigue, hydrogen embrittlement, and stress cracking. Failure encountered in parts of the main landing gear of the B-36 receives particular study.

Silicon-iron alloy MAGNETIC PROPERTIES OF 6.4 PERCENT SILICON-IRON SHEET MATERIAL. *J. F. Nachman and W. J. Buehler, Naval Ordnance Laboratory. May 1956. 20 pp. Available from Office of Technical Services, Dept. of Commerce, Wash. 25, D. C. 50¢ (PB 121545)*

Evaluation of a silicon-iron alloy for synchro, transformer and magnetic amplifier applications. Describes processing and magnetic annealing techniques which produce a polycrystalline 6.4% silicon-iron sheet. Evaluation shows the material to possess high initial and maximum permeability and moderately rec-

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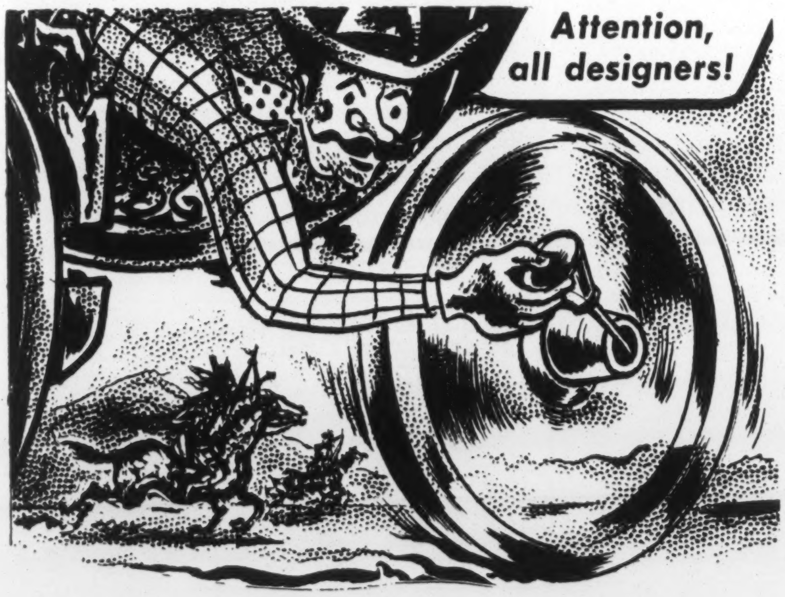
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BOOKS & REPORTS

tangular hysteresis loop. However, the addition of silicon over 5% decreases ductility of the iron and renders the alloy almost incapable of being cold-rolled into sheets.

Nickel filler metals TENTATIVE SPECIFICATION FOR NICKEL AND NICKEL-BASE ALLOY BARE WELDING FILLER METALS. *Available from American Welding Society, 33 W. 39th St., New York 18, N. Y. 40¢ (AWS A5.14)*

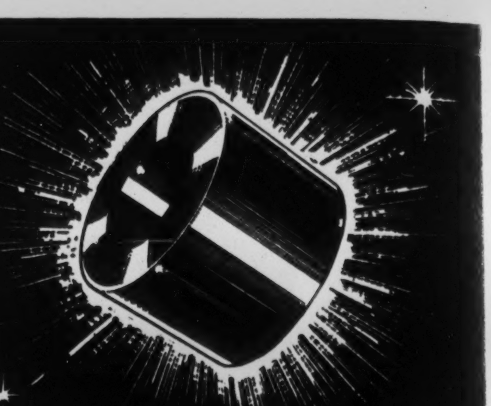
Covers bare filler metals for the welding of nickel and high nickel alloys. Establishes 13 classifications of filler metal, including nickel, Monel, K Monel, Inconel, Inconel X and various Hastelloy filler metals. Chemical analysis of the different classifications is given in a table.

Aircraft metals INVESTIGATION OF THE COMPRESSIVE, BEARING AND SHEAR CREEP-RUPTURE PROPERTIES OF AIRCRAFT STRUCTURAL METALS AND JOINTS AT ELEVATED TEMPERATURES, PART 1. *F. J. Vawter and others, Cornell Aeronautical Lab. June 1956. 194 pp. Available from Office of Technical Services, Dept. of Commerce, Wash. 25, D. C. $2.50 (PB 121436)*

Describes equipment and special fixtures for conducting tensile, compression, bearing and shear creep tests on aircraft structural metals and joints at elevated temperatures. Tensile creep properties are reported at several temperatures for 2024-T3 aluminum sheet, C-110M titanium sheet, type 321 stainless steel sheet, and rivet wires of 2117-T4 aluminum, Monel, and type 301 stainless steel.

Reinforced alloys A STUDY OF THE POSSIBILITY OF REINFORCED HIGH-TEMPERATURE ALLOYS BY ADDITION OF REFRACTORY POWDERS. *J. D. Burney, P. R. Mallory & Co. Inc. May 1956. 42 pp. Available from Office of Technical Services, Dept. of Commerce, Wash. 25, D. C. $1.25 (PB 121474)*

Outlines the possibility of reinforcing a nickel-chromium alloy by the addition of stable refractory oxides. Emphasis is placed on type, amount and particle size of the oxide and techniques for its proper dispersion with the base alloy. Greatly improved stress-rupture characteristics, compared with those of a wrought nickel-chromium alloy were indicated for the alloy reinforced with 1% aluminum oxide. Room temperature impact and ultimate tensile strength appeared adequate.



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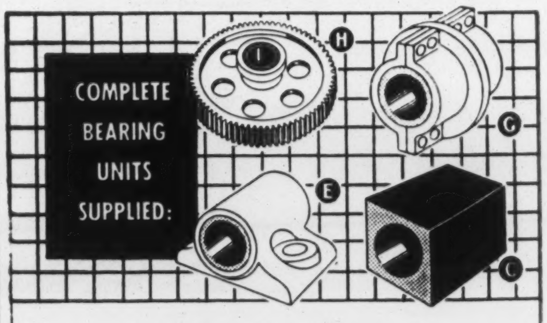

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THE LAST WORD

by ***H. R. Clauser,*** *Editor*

Thanks

Now that the judging is completed and the winners in the first M&M Awards Competition have been announced (see p 148), I would like to publicly thank the four judges—Joseph Bonanno, Walter Dorwin Teague, John Nielsen and John Seastone—for a highly commendable job.

Both the value and success of any awards program depends to a large extent on the quality of the judging. It is a well-known, but unfortunate, fact that in many competitions the job of the judges is merely perfunctory. This was far from the case in the M&M competition.

The judges labored long and hard at the difficult task of evaluating the many entries and selecting the most deserving for awards. We were indeed fortunate in having four men who brought to the task of judging a broad and expert knowledge of materials as well as a thorough understanding of the purposes of this Awards program.

A Portable One-Seater

If you attend the Design Engineering Show this month (and we hope you do) be sure to pay us a visit at our booth. (No. 425-431). We not only would like to meet you, but would also like to show you the display of products that won prizes in the Awards Competition. One of the winning products that is likely to attract a lot of attention to our booth is the portable toilet which deservedly won an Award of Merit. But in order to forestall any experiments by those curious engineers who are forever wondering how things work, we plan to post a sign on the fixture that will read "Out of Order."

California and the Shakes

I was leaning back comfortably in a chair in a Kaiser Aluminum Co. office in Oakland, California, just across the bay from San Francisco, quietly discussing an article with Dudley Ross and Harrison Beardsley when the earthquake struck. There were long seconds of rocking and trembling, then some more seconds of vibration. Being an Easterner and having been brought up a Baptist, my first thought naturally was that this was the end of the world. By the time we ran to the nearest doorway (which is supposed to be the safest spot during an earthquake) it was over.

And that was my introduction to California. Despite the earthquake, I had a fine trip: I met a lot of readers, visited a number of aircraft plants, and attended the Western Plastics Exposition and the Western Metal Congress. Like most visitors, I was tremendously impressed by the advanced work being done on the Coast in all phases of engineering and design.

Paying for Free Information

During the Western Metal Congress, I attended a session of the special titanium symposium sponsored by the Metals Engineering Institute of the American Society for Metals. The charge to sit in on this symposium was $125. Fortunately I had a press pass. But I talked to a number of people who were not as fortunate and who could not justify the cost even on their expense account.

I seriously question the wisdom of holding special symposia for which there is such a high admission charge during an otherwise open and free convention. It was difficult for me to see how the type of papers delivered at this titanium symposium differed from those given in sessions on other topics. As far as I know, the speakers were not paid and the preprints were no more elaborate than those commonly available at other technical society meetings. Furthermore, the information was not obtained through research projects paid for by ASM. I suspect that much of the information presented was obtained under government contract. If this is the case, all technical people are entitled to hear the papers without charge, and the information and data should receive the widest possible dissemination rather than being restricted through a high admission charge.